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SEALED-IN WINTER STORES OF RED-HEADED WOODPECKERS

BY LAWRENCE KILHAM

WINTERING Red-headed Woodpeckers (*Melanerpes erythrocephalus*) have been numerous along the Potomac River and the Chesapeake and Ohio Canal, attracted mainly by pin oaks (*Quercus palustris*) in bottomlands extending for several miles up and down stream from Seneca, Montgomery County, Maryland. The present communication describes the systematic way in which these woodpeckers harvest and store acorns, then seal their stores from view, apparently as protection against theft by other animals. Closely guarded winter territories, which will be the subject of a second report, afford additional protection. Two observations suggest that the birds are closely dependent on the oaks. First, pin oak acorns make up a large part of their winter stores and, second, Red-headed Woodpeckers were absent from the area in the winter of 1953–1954 when the acorn crop failed.

HARVESTING OF ACORNS

The woodpeckers were studied in two areas of woodland; one along the canal and the other a grove largely surrounded by fields. Upon their arrival in the first part of September Red-headed Woodpeckers started collecting acorns, and, in 1956, continued to do so through the first week in November, by which time the oaks had been denuded. When harvesting acorns, the woodpeckers were most energetic, flying back and forth from their individual territories to the nearer acorn-bearing oaks. Thus, three or four of them might come to a single tree. A Red-headed Woodpecker would cling in awkward fashion, often upside down, in order to work an acorn loose from its cup. When returning with an acorn in its bill, a woodpecker usually would fly downward, then up to some broken stub which served as an anvil. Here it would hammer an acorn into pieces and devour some of the crumbs before looking for a storage place. Storage in this first phase consisted in pushing whole acorns or sections of acorns into cracks and crevices wherever available, whether in furrowed or loose bark, splintered stumps, dead limbs, or where vines grew around tree trunks. Since competition for acorns was keen, the hastiness of this initial storage may have insured a maximum harvest while the supply lasted. The principal avian competitors in woodlands under observation were Tufted Titmice (*Parus bicolor*) and Blue Jays (*Cyanocitta cristata*). Both these species were observed storing acorns on the ground, at a distance from the pin oaks. Crows (*Corvus brachyrhynchos*) and Red-bellied Woodpeckers (*Centurus carolinus*) were additional competitors. The last two species were chased away by the Red-headed Woodpeckers on all possible occasions. After depletion of the crop in the oaks, Red-headed Wood-

peckers harvested from the ground below, many acorns having fallen while the picking was going on above. Further collection of acorns during the winter was only sporadic. Only two Red-headed Woodpeckers, both immature, were observed in mid-winter flying to distant oaks of another species to collect larger acorns.

Re-storage

The Red-headed Woodpeckers, of which 12 were under special observation, were active in the late fall, taking acorns or fragments of them from one crevice to another on the same or more often on another tree for re-storage in situations ranging from high limbs to holes two or three feet from the ground. Whole acorns might be split, prior to re-storage, on some broken stub serving as an anvil. A general impression was that the woodpeckers were distributing their stores as widely as possible within their territories, and one might speculate that such a dispersal would prevent any rodent or bird competitor, if successful, from stealing too much at one time. Acorns were hammered so tightly into crevices that it was difficult to dislodge them. For example, a Blue Jay under observation worked vigorously before extracting a stored acorn. The jay had time for the operation only because two other jays were distracting the woodpecker involved. Red-headed Woodpeckers had their greatest difficulties with Tufted Titmice, since five or six of these birds might invade a single woodpecker territory at a time. It became apparent, after some months of observation, that the woodpeckers had, in addition to wide dispersal, firm wedging in crevices and constant guarding of their stores, a still further method of protecting them.

Walling-in of Winter Stores

On November 18, 1956, I observed a type of behavior which I had not witnessed previously. It was exhibited by four different Red-headed Woodpeckers within a few hours. One, for example, flew back and forth five times from a rotten stub. On each occasion it would hammer vigorously, and finally loosen a sliver of wood 1 to 1½ inches in length. The woodpecker would arrange the sliver to point forward from its bill, then fly directly to another tree. The slivers were hammered into crevices, and all loose and shredded ends were gathered up and pounded firmly into place. Although I noticed individual birds carrying splinters on succeeding week ends until January 12, 1957, it was only on December 16, 1956, that I again noticed numbers of woodpeckers simultaneously engaged at this occupation. On the latter date I walked through four adjacent winter territories and observed the occupants of each making regular trips to rotten limbs or stubs. Splinters collected by the woodpeckers were all hammered in place elsewhere. It was puzzling to consider why, as on November 18, numbers of Red-headed Woodpeckers should be doing the same thing on the same morning, a type of

behavior that they had performed only rarely in intervening periods. A chance observation gave an answer to this problem. One Red-headed Woodpecker on December 16 was trying to handle an especially long sliver, the ends of which hung down as limply as wet paper. It then occurred to me that the wood had been soaked by a heavy rain on the preceding night. I worked a sliver loose from a damp rotten log and found that it could be readily molded into a crevice. The Red-headed Woodpeckers apparently were doing just that. Upon reviewing my notes I found that the morning of November 18 had also been preceded by a heavy rain, a circumstance which appears to incite these woodpeckers to collect splinters of damp wood.

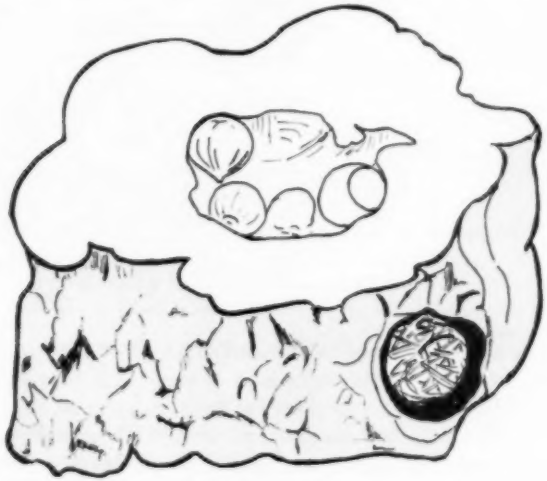

FIG. 1. Diagrammatic cross section of a dead stub. The natural cavity, used for storing acorns, was reached by a round hole drilled at one side. This entrance was sealed later with splintered wood.

Seeking more direct observations, my son and I brought a ladder and a hand saw to the study area on December 22. We were now able to inspect storage trees in some detail. It was readily apparent that acorns stored in various cavities from near the ground to high up in trees had been completely sealed in by means of shredded bits of wood which had become firm on drying. We sawed off branches, stubs, and boles on trunks for closer study. These specimens are illustrated in accompanying figures. Figure 1 shows a diagrammatic cross section of a dead stub which projected from a black cherry tree (*Prunus serotina*). The woodpecker apparently had drilled a round hole ½ inch in diameter into a natural cavity within the heart wood.

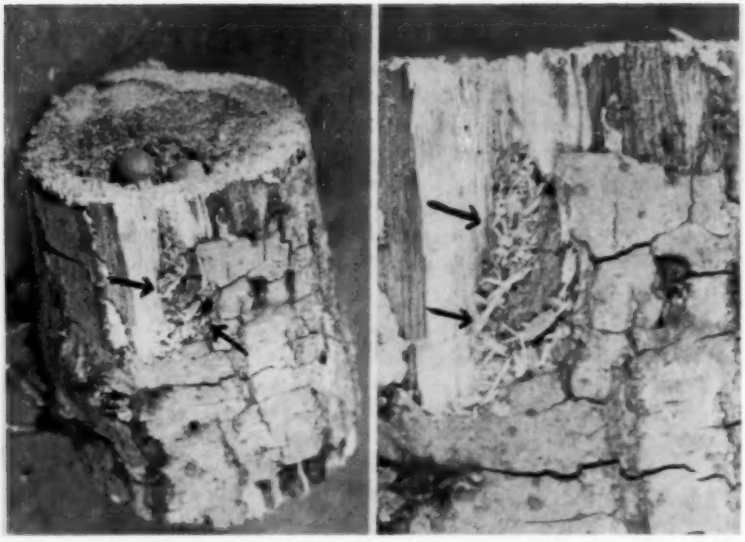

FIG. 2 (*left*). Pin oak acorns stored within a dead stump six feet above ground. The elliptical entranceway is sealed with splintered wood and a piece of bark.
FIG. 3 (*right*). Detailed view of the sealed entrance shown in Fig. 2.

The cavity, when sawed open, was found to be filled with whole acorns, hidden from view by a sealed entrance.

Two more drawings (Fig. 4) show the front and reverse sides of a bole sawed from a hackberry tree (*Celtis occidentalis*). The small entrance hole, ¼ inch in diameter, was easily seen from the ground because it was plugged by a wad of pale splinters that contrasted with the surrounding bark. A cluster of insect remains filled the inner cavity. The insect fragments were identified by members of the Entomology Research Branch, U.S. Department of Agriculture. The cache included a wasp (*Polistes fuscatus* F., *sens. lat.*), a cricket (*Melanopus* sp.), pupal remains of 2 species of moth (Arctiidae) and a carabid beetle (*Harpalus* sp.). No other caches of insects were encountered. Figure 5 is a longitudinal section of a swamp cottonwood (*Populus heterophylla*), showing acorns rammed in linear fashion down the hollow heart wood. Obviously such acorns could not be removed by the same opening through which they were inserted. It became evident as the winter progressed that the Red-headed Woodpeckers had to chisel away wood to remove stores pushed into natural cavities through small apertures. Most of the stores discovered were sealed in. Uncovered caches usually consisted of one or two acorns in shallow depressions.

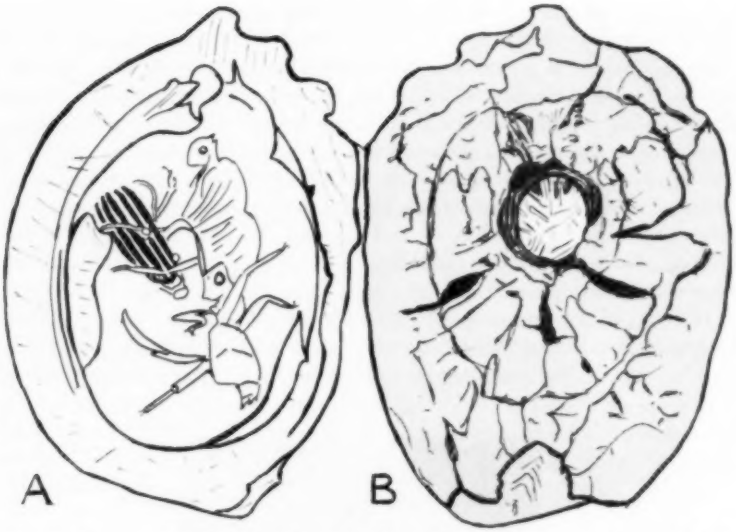

FIG. 4. Reverse (A) and front (B) views of a bole sawed from a small tree. A Red-headed Woodpecker filled the natural cavity with insects, then sealed the round entrance shown in (B) with splintered wood.

OTHER WINTER FOOD

The Red-headed Woodpeckers caught insects on warm days during the winter, even in January, often by clinging to the uppermost twigs on a tree, then flying out with rapidly beating wings to make their catch with a final upward swoop. Some individuals appeared to catch insects on the ground in an open field. Red-headed Woodpeckers with territories several hundred yards from a corn field made trips there to pick up kernels from the ground. The woodpeckers were much attracted to sap. When sap flowed from holes drilled by Yellow-bellied Sapsuckers (*Sphyrapicus varius*), which appeared to be only at times of freezing nights and thawing days during the fall, winter, and spring (Kilham, 1956*a*), Red-headed Woodpeckers fed from the holes in systematic fashion. One could see sap glistening on their bills. Most of the individuals involved were those with territories either containing or closely adjacent to a sapsucker tree. Unlike other species of woodpeckers in the vicinity, Red-headed Woodpeckers were not seen eating berries of any kind.

DISCUSSION

Red-headed Woodpeckers observed in the vicinity of Seneca, Maryland, are remarkably efficient at storing and protecting a winter supply of acorns.

Guarding of individual territories in which the acorns were stored, although effective against other woodpeckers, appeared to be less effective against birds which came in groups, such as Tufted Titmice and Blue Jays. The Red-headed Woodpeckers had at least three methods of preventing other birds from robbing their stores. First, acorns were stored widely, with no great concentration in any one place; second, they were wedged so tightly in crevices that it was difficult to work them loose. The third and most interesting method was the hammering and molding of splinters of damp, semi-rotten wood, along with bits of bark, to seal off holes leading to storage cavities. When dry, such entranceways were somewhat camouflaged and were not readily opened.

The only other report of sealing in of stores by the Red-headed Woodpecker known to me is that of Hay (1887). He described this woodpecker in Indiana as a hoarder, hiding great numbers of beech nuts in every conceivable situa-

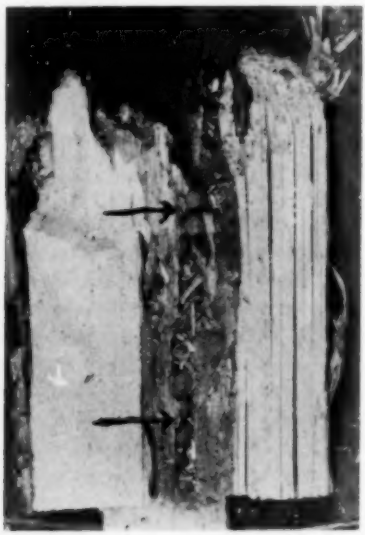

FIG. 5. Pin oak acorns rammed into the hollow core of a dead swamp cottonwood.

tion. Hay stated further that (p. 195) ". . . afterwards pieces of bark and wood have been brought and driven down over the nuts as if to hide them from poachers. These pieces of bark are sometimes an inch or more square and half an inch thick and driven in with such force that it is difficult to get

them out. In one case the nuts were covered over with a layer of empty involucres."

These methods of sealing in caches have not been noted among other acorn-storing woodpeckers, of which the Red-bellied was the only one observed in the Maryland area. According to Ritter (1938) the California Woodpecker (*Melanerpes formicivorus bairdi*) stores acorns in large numbers, each within a single hole made for the purpose in pine bark. His photographs show hundreds of acorns studding a pine tree, but none is covered from view.

Two other groups of birds have a habit of sealing off entrance holes. The British Nuthatch (*Sitta europaea affinis*) may reduce the size of nest holes and fill crevices with hard mud (Witherby, Jourdain, Ticehurst, and Tucker, 1940:242). Female Hornbills of many species wall themselves into nest holes, leaving a slit through which their mates can feed them. In one African species (*Bycanistes subcylindricus*) studied by Kilham (1956*b*), the earth used for cementing walls was obtained principally from termite mounds. The material used by Red-headed Woodpeckers to seal holes appears to be unique among birds.

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7815 Aberdeen Road, Bethesda, Maryland, March 21, 1957

WEIGHTS AND WEIGHT VARIATIONS IN SUMMER BIRDS FROM GEORGIA AND SOUTH CAROLINA

BY ROBERT A. NORRIS AND DAVID W. JOHNSTON

For most of the southeastern United States, Georgia and South Carolina included, relatively few data on weights of birds have been collected and fewer still have seen the light of publication. Accordingly, it seems desirable to place on record a summary of weights of approximately 576 individuals, representing 97 species, which were taken in the summers of 1947, 1948, 1951, 1955, and 1956, in southern parts of Georgia and South Carolina. All the weights pertain to collected specimens, of which the majority are deposited in collections of the Department of Zoology, University of Georgia, Athens; the Museum of Vertebrate Zoology, University of California, Berkeley; the Malarial Investigations Station, Newton, Georgia; and the Department of Biology, Mercer University, Macon, Georgia. Most of the birds were collected on the Upper Coastal Plain of south-central and southwestern Georgia. Some were taken as far north and east as Macon, Bibb County, Georgia, and the Savannah River Plant area, Aiken and Barnwell counties, South Carolina. Nearly all the specimens were from areas less than 400 feet above sea level, but occasional ones came from elevations as high as 600 feet. Thirty-odd individuals were obtained along the Georgia coast from Chatham to Camden counties, these being mainly littoral or coast-dwelling species. On the whole the region in which the birds were taken was rather uniform and may be regarded as a satisfactory unit within which one would expect to find very little geographic variation in bird weights.

Methods

Most of the weights were taken with double-beam balances. A few were taken with a more sensitive triple-beam balance. Individual weights were recorded to the nearest tenth gram for birds weighing less than 100 grams, and to the nearest gram for larger birds. The specimens were collected with shotguns and carried in paper cones, and only rarely was there considerable loss of blood. Practically all were obtained between 9:00 a.m. and 4:00 p.m. Weight variations due to normal daily fluctuations, in which weights are lightest in the early morning and heaviest in the late afternoon (see Baldwin and Kendeigh, 1938:424–430), were thus held to a minimum or at least restricted somewhat. We believed there was little weight loss following death because the birds were usually weighed within two or three hours after they were collected. When there were longer delays, they were usually placed in a refrigerator as soon as possible.

Because of the paucity of recorded weights from the southeastern United States we are in certain instances presenting weight values for single speci-

mens. It is true that one might ask, "Is it worth while publishing a single weight of, say, a Black Skimmer?" We think so. So far as we know, no one besides ourselves has weighed a skimmer in either Georgia or South Carolina, and it seems unlikely that anyone, including ourselves, will weigh another for some time to come. Hence we feel this single record and others like it should be made available.

The best way to present data here is by sex and age, both of which were determinable for the majority of our specimens. Thus, in Table 1, "M" refers to male, "F" to female, "a" to adult, and "i" to immature. Very few of the weights pertain to females containing large or full-sized eggs. Immaturity in passerine species was ascertained not only by external characters but also by the thin, unossified areas in the skull. All the immatures were out of the nest and were in full feather, and essentially all were independent of their parents. Age could not always be determined in migrant non-passerine species.

For each category an average or mean weight value is given, whether it represent one or be based on two or more individuals. Parentheses enclose data for single specimens. Where two or more specimens are involved in a sample, the average is followed by the standard error of the mean. In a sample of two this standard-error value is equivalent to one-half the range between the two weight values, or to the difference between the mean and either of those values. In larger samples this simple relationship does not obtain. In order to present the data in brief yet useful fashion, we chose the standard error, as opposed to the standard deviation, as the best single statistic or parameter to be given with the mean.

The summer period in which a given sample was collected has been handled in a similar way. For a given sample in Table 1, the numerical values *following* the semicolon refer, first, to the "mean day" of the summer period in which the sample was taken and, second, to the standard error of the mean in whole days. These statistics were ascertained on the basis of the following scale: June 1 to 30 (numbers 1 to 30), July 1 to 31 (numbers 31 to 61), August 1 to 31 (numbers 62 to 92), and September 1 to 15 (numbers 93 to 107). Even though the days on which a sample was collected are distributed as a non-normal statistical array, it nevertheless seems justified to employ the same statistics for a given summer period as we have for a sample of weights. In doing so we not only insure brevity but also enable one to determine, if necessary, whether two samples, which one might wish to compare closely, were indeed obtained at strictly comparable times of summer. A fairly rigorous check could be accomplished by an ordinary *t*-test which, according to one conventional formula (Arkin and Colton, 1939:121), would employ the difference between the respective mean values as well as the standard-error values (specifically, the square root of the sum of their squares).

For small samples, at least, the *t*-probability scale (which may be found in elementary books on statistics) is justified and may be used "even if the population varies very considerably from normal" (a conjecture of E. S. Pearson's confirmed by Gayen, 1950).

TABLE 1

STATISTICAL ANALYSIS OF WEIGHTS OF SUMMER BIRDS FROM GEORGIA AND SOUTH CAROLINA

Pied-billed Grebe. *Podilymbus podiceps.*—2 Ma: 438.0 ± 3.0; 56 ± 3.
Anhinga. *Anhinga anhinga.*—Ma (1326; 75).
Little Blue Heron. *Florida caerulea.*—Mi (348; 36).—Fa (352; 56).—Fi (296; 53).
Green Heron. *Butorides virescens.*—Fa (229; 71).—Fi (173; 75).
Snowy Egret. *Leucophoyx thula.*—M (342; 62).
Louisiana Heron. *Hydranassa tricolor.*—Fi (402; 43).
Yellow-crowned Night Heron. *Nyctanassa violacea.*—2MF?i: 426.5 ± 35.5; 33 ± 1.
Red-tailed Hawk. *Buteo jamaicensis.*—Fi (1134; 39).
Broad-winged Hawk. *Buteo platypterus.*—Ma (349; 60).
American Kestrel. *Falco sparverius.*—2 Fa: 97.55 ± 1.95; 43 ± 8.
Bobwhite. *Colinus virginianus.*—2 Ma: 152.0 ± 1.0; 54 ± 18.
Purple Gallinule. *Porphyrula martinica.*—Ma (220; 30).—Fa (200; 75).
Common Gallinule. *Gallinula chloropus.*—Fi (259; 74).
American Coot. *Fulica americana.*—2 Fa: 556.0 ± 23.4; 72 ± 0.
Thick-billed Plover. *Charadrius wilsonia.*—2 Ma: 64.90 ± 1.10; 45 ± 39.
Killdeer. *Charadrius vociferus.*—2 Ma: 75.60 ± 3.60; 44 ± 16.—Fa (85.5; 37).
Spotted Sandpiper *Actitis macularia.*—Fa (40.5; 43).
Solitary Sandpiper. *Tringa solitaria.*—3 M: 61.30[4] ± 2.58; 74 ± 0.
Willet. *Catoptrophorus semipalmatus.*—Ma (222; 48).
Least Sandpiper. *Erolia minutilla.*—M (21.1[2]; 85).—F (18.6; 80).
Semipalmated Sandpiper. *Ereunetes pusillus.*—F (28.1[5]; 86).
Least Tern. *Sterna albifrons.*—Ma (50.5; 58).—Fi (48.6; 48).
Black Tern. *Chlidonias niger.*—Ma (50.6; 59).
Black Skimmer. *Rhynchops nigra.*—Ma (373; 48).
Mourning Dove. *Zenaidura macroura.*—3 Ma: 126.7[2] ± 3.2; 80 ± 4.
Ground Dove. *Columbigallina passerina.*—MF?a (40.7; 23).
Yellow-billed Cuckoo. *Coccyzus americanus.*—M (54.6; 59).—F (61.2; 62).
Common Nighthawk. *Chordeiles minor.*—Fa (57.8; 23).
Chimney Swift. *Chaetura pelagica.*—2 M: 22.50 ± 0.35; 89 ± 0.
Red-bellied Woodpecker. *Centurus carolinus.*—6 Ma: 73.08 ± 2.61; 66 ± 5.—5 Mi: 68:52 ± 2.91; 66 ± 7.—6 Fa: 65.50 ± 2.04; 63 ± 6.—2 Fi: 62.75 ± 1.15; 86 ± 2.
Hairy Woodpecker. *Dendrocopos villosus.*—Ma (58.7; 45).—2 Fa: 50.15 ± 1.75; 79 ± 1.
Downy Woodpecker. *Dendrocopos pubescens.*—Ma (23.2; 47).—4 Fa: 21.30 ± 0.44; 64 ± 15.
Red-cockaded Woodpecker. *Dendrocopos borealis.*—2 Ma: 48.00 ± 1.00; 32 ± 4.—Mi (42.8; 37).—Fa (39.0; 62).
Eastern Kingbird. *Tyrannus tyrannus.*—3 Ma: 37.17 ± 1.18; 61 ± 5.—Mi (35.7; 63).—2 Fa: 35.60 ± 0.60; 64 ± 6.—Fi (38.4[1]; 80).
Crested Flycatcher. *Myiarchus crinitus.*—2 Ma: 37.65 ± 0.15; 46 ± 45.—4 Mi: 33.40 ± 1.14; 60 ± 8.—Fa (30.8; 51).—Fi (30.5; 47).

Acadian Flycatcher. *Empidonax virescens.*—2 Ma: 14.05 ± 0.75; 61 ± 20.—2 Fa: 11.95 ± 0.35; 64 ± 17.

Eastern Wood Pewee. *Contopus virens.*—4 Ma: 13.82 ± 0.29; 50 ± 4.

Bank Swallow. *Riparia riparia.*—Ma (14.2[4]; 92).

Rough-winged Swallow. *Stelgidopteryx ruficollis.*—M (18.8[2]; 51).

Barn Swallow. *Hirundo rustica.*—Ma (20.9; 76).—Mi (16.7; 105).

Purple Martin. *Progne subis.*—Mi (44.0; 47).

Blue Jay. *Cyanocitta cristata.*—12 Ma: 77.22 ± 2.23; 60 ± 6.—7Mi: 79.81 ± 3.62; 60 ± 7.—Fa (75.5; 77).—2 Fi: 72.90 ± 7.50; 72 ± 19.

Common Crow. *Corvus brachyrhynchos.*—6 Ma: 460.3 ± 13.5; 35 ± 15.—8 Fa: 395.4 ± 6.2; 25 ± 6.—3 Fi: 395.0 ± 13.3; 46 ± 18.

Fish Crow. *Corvus ossifragus.*—3 Ma: 305.7 ± 10.9; 13 ± 13.—Mi (293; 38).—2 Fa: 278.5 ± 9.5; 72 ± 19.

Carolina Chickadee. *Parus carolinensis.*—5 Ma: 9.44 ± 0.20; 60 ± 11.—4 Fa: 8.58 ± 0.25; 60 ± 9.

Tufted Titmouse. *Parus bicolor.*—5 Ma: 20.62 ± 0.84; 61 ± 13.—8 Mi: 21.11 ± 0.57; 71 ± 8.—2 Fa: 18.80 ± 1.00; 38 ± 5.—3 Fi: 18.80 ± 0.69; 64 ± 16.

White-breasted Nuthatch. *Sitta carolinensis.*—Mi (19.1; 39).

Brown-headed Nuthatch. *Sitta pusilla.*—17 Ma: 10.11 ± 0.19; 58 ± 6.—11 Mi: 10.26 ± 0.29; 48 ± 6.—10 Fa: 9.86 ± 0.18; 56 ± 7.—6 Fi: 9.58 ± 0.27; 56 ± 10.

Carolina Wren. *Thryothorus ludovicianus.*—3 Ma: 20.57 ± 1.79; 44 ± 14.—3 Fa: 16.77 ± 0.56; 39 ± 13.

Long-billed Marsh Wren. *Telmatodytes palustris.*—M?i (10.9; 85).—Fa (8.9; 50).—Fi (9.0; 86).

Mockingbird. *Mimus polyglottos.*—8 Ma: 50.20 ± 1.17; 52 ± 5.—6 Mi: 51.05 ± 1.08; 60 ± 10.—4 Fa: 47.48 ± 2.19; 48 ± 5.—5 Fi: 48.62 ± 1.41; 59 ± 6.

Catbird. *Dumetella carolinensis.*—Ma (40.0; 44).

Brown Thrasher. *Toxostoma rufum.*—Mi (75.5; 68).—3 Fa: 69.80 ± 0.23; 81 ± 5.—Fi (64.5; 29).

Wood Thrush. *Hylocichla mustelina.*—Fa (44.5; 74).

Eastern Bluebird. *Sialia sialis.*—Ma (30.5; 40).—Mi (23.4; 58).—2 Fa: 25.45 ± 0.05; 57 ± 2.

Blue-gray Gnatcatcher. *Polioptila caerulea.*—Ma (5.2; 47).—3 Mi: 5.87 ± 0.39; 39 ± 7.—2 Fa: 6.20 ± 1.00; 52 ± 20.—Fi (6.2; 53).

Loggerhead Shrike. *Lanius ludovicianus.*—4 Ma: 51.48 ± 0.85; 74 ± 8.—Mi (53.5; 50).—Fa (45.9; 73).—4 Fi: 45.20 ± 2.16; 52 ± 9.

Common Starling. *Sturnus vulgaris.*—2 Mi: 82.65 ± 2.55; 39 ± 0.

White-eyed Vireo. *Vireo griseus.*—8 Ma: 12.64 ± 0.31; 74 ± 7.—8 Mi: 12.51 ± 0.36; 69 ± 8.—4 Fa: 12.92 ± 0.36; 60 ± 9.—Fi (12.7; 85).

Yellow-throated Vireo. *Vireo flavifrons.*—3 Ma: 16.06 ± 0.56; 50 ± 15.—Mi (17.9; 71).

Red-eyed Vireo. *Vireo olivaceus.*—Ma (14.3; 48).—3 Mi: 18.77[3] ± 1.16; 59 ± 11.—Fa (17.9[3]; 53).—2 Fi: 17.10[2] ± 0.40; 67 ± 14.

Black-and-white Warbler. *Mniotilta varia.*—Mi (13.8[5]; 85).—Fa (10.9; 76).

Prothonotary Warbler. *Protonotaria citrea.*—Ma (13.2; 25).—3 Mi: 13.70[3] ± 0.38; 47 ± 17.—Fa (12.7; 43).

Swainson's Warbler. *Limnothlypis swainsonii.*—2 Ma: 16.60[3] ± 0.11; 63 ± 7.

Worm-eating Warbler. *Helmitheros vermivorus.*—3 Mi: 13.50[2] ± 0.49; 69 ± 0.—Fi 12.9[4]; 78).

Golden-winged Warbler. *Vermivora chrysoptera.*—2 Mi: 9.20[2] ± 1.00; 95 ± 0.

Blue-winged Warbler. *Vermivora pinus.*—Fi (9.1[2]; 85).

Parula Warbler. *Parula americana.*—6 Ma: 7.81 ± 0.25; 41 ± 10.—Mi (7.6[2]; 53).—Fa (8.4[3]; 70).—6 Fi: 7.38 ±0.19; 56 ± 7.

Cerulean Warbler. *Dendroica cerulea.*—Ma (12.4[3]; 90).—Mi (9.4[2]; 74).—5 Fi: 10.82[4] ± 0.73; 80 ± 4.

Yellow-throated Warbler. *Dendroica dominica.*—4 Ma: 10.35 ± 0.22; 76 ± 7.—4 Mi: 10.60 ± 0.38; 72 ± 10.—2 Fa: 10.75 ± 0.45; 86 ± 4.—6 Fi: 10.23 ± 0.26; 79 ± 9.

Chestnut-sided Warbler. *Dendroica pensylvanica.*—F?i (10.2[2]; 90).

Pine Warbler. *Dendroica pinus.*—2 Ma: 12.40 ± 1.70; 60 ± 18.—5 Mi: 13.25 ± 0.20; 68 ± 3.—2 Fa: 12.20 ± 0; 64 ± 4.—2 Fi: 12.60 ± 0.10; 73 ± 5.

Prairie Warbler. *Dendroica discolor.*—2 Ma: 7.25 ± 0.55; 71 ± 6.—Fa (7.3; 47).—3 Fi: 7.20[2] ± 0.45; 70 ± 11.

Ovenbird. *Seiurus aurocapillus.*—Mi (19.0[1]; 90).

Northern Waterthrush. *Seiurus noveboracensis.*—3 Mi: 18.60[4] ± 2.05; 89 ± 3.

Louisiana Waterthrush. *Seiurus motacilla.*—Mi (20.2; 74).—Fa (21.6; 47).

Kentucky Warbler. *Oporornis formosus.*—3 Ma: 14.23[2] ± 0.76; 72 ± 20.—4 Mi: 14.18[1] ± 0.74; 48 ± 7.—Fi (14.6[2]; 62).

Common Yellow-throat. *Geothlypis trichas.*—2 Ma: 10.65 ± 0.65; 28 ± 6.—3 Mi: 9.63 ± 0.48; 58 ± 13.—2 Fi: 10.10 ± 0.80; 46 ± 1.

Yellow-breasted Chat. *Icteria virens.*—3 Ma: 25.57 ± 0.61; 50 ± 3.

Hooded Warbler. *Wilsonia citrina.*—3 Ma: 10.47 ± 0.07; 60 ± 12.—4 Mi: 12.78[3] ± 0.96; 72 ± 4.—Fa (9.5; 43).—2 Fi: 11.95[1] ± 0.45; 64 ± 8.

American Redstart. *Setophaga ruticilla.*—Ma (9.7[3]; 81).—3 Mi: 9.60[4] ± 0.83; 87 ± 10.

Eastern Meadowlark. *Sturnella magna.*—6 Ma: 104.8 ± 2.8; 66 ± 7.

Red-winged Blackbird. *Agelaius phoeniceus.*—3 Ma: 52.8 ± 2.56; 42 ± 6.—Mi (51.2; 89).—4 Fa: 35.60 ± 0.87; 61 ± 7.—2 Fi: 36.15 ± 0.55; 79 ± 0.

Common Grackle. *Quiscalus quiscula.*—Ma (107; 36).—Fi (76.6; 45).

Brown-headed Cowbird. *Molothrus ater.*—Ma (52.2; 103).

Summer Tanager. *Piranga rubra.*—3 Ma: 30.20 ± 0.91; 59 ± 19.—3 Fa: 28.87 ± 0.34; 33 ± 7.

Cardinal. *Richmondena cardinalis.*—7 Ma: 39.31 ± 0.50; 61 ± 9.—8 Mi: 39.52 ± 0.56; 61 ± 4.—10 Fa: 38.03 ± 0.86; 47 ± 5.—3 Fi: 34.86 ± 0.77; 66 ± 9.

Blue Grosbeak. *Guiraca caerulea.*—6 Ma: 29.13 ± 0.46; 71 ± 11.—2 Mi: 28.80 ± 1.30; 92 ± 2.—3 Fa: 26.30 ± 0.68; 60 ± 3.—Fi (24.5; 66).

Indigo Bunting. *Passerina cyanea.*—2 Ma: 13.30 ± 0.70; 44 ± 18.—2 Fi: 13.95[2] ± 0.05; 86 ± 3.

Painted Bunting. *Passerina ciris.*—2 Ma: 15.75 ± 0.25; 50 ± 2.—2 Mi: 15.15 ± 1.05; 84 ± 1.—2 Fi: 14.15 ± 0.05; 94 ± 14.

American Goldfinch. *Spinus tristis.*—2 Ma: 11.40 ± 0.40; 67 ± 13.

Rufous-sided Towhee. *Pipilo erythrophthalmus.*—11 Ma: 45.54 ± 0.53; 59 ± 7.—4 Mi: 42.35 ± 1.01; 50 ± 15.—6 Fa: 44.10 ± 1.86; 38 ± 3.—3 Fi: 41.47 ± 0.72; 81 ± 4.

Grasshopper Sparrow. *Ammodramus savannarum.*—Ma (16.0; 56).

Seaside Sparrow. *Ammospiza maritima.*—5 Ma: 24.08 ± 0.96; 71 ± 9.—2 Mi: 20.20 ± 0.60; 50 ± 0.—2 Fa: 24.45 ± 2.25; 68 ± 18.

Pine-woods Sparrow. *Aimophila aestivalis.*—7 Ma: 19.08 ± 0.14; 49 ± 7.—2 Mi: 18.65 ± 1.65; 70 ± 18.—2 Fa: 19.20 ± 0.80; 56 ± 28.—2 Fi: 16.45 ± 0.35; 58 ± 5.

Chipping Sparrow. *Spizella passerina.*—4 Ma: 11.62 ± 0.02; 65 ± 5.—Fa (10.4; 67).—Fi (11.1; 76).

Field Sparrow. *Spizella pusilla.*—3 Ma: 12.30 ± 0.15; 56 ± 15.—2 Mi: 12.80[2] ± 0.60; 84 ± 4.—4 Fa: 11.15 ± 0.30; 56 ± 14.—6 Fi: 11.55[1] ± 0.42; 59 ± 11.

Some of the specimens were migrants and were more or less fat. Degree of fatness, which ought to be considered in appraising bird weights (see Johnston and Haines, 1957), is indicated by superscript numbers given in conjunction with mean values. The numbers refer to the McCabe scale of fat classes (McCabe, 1943), thus: (0) no fat, (1) little fat, (2) moderate fat, (3) fat, (4) very fat, and (5) excessive fat. Mean values lacking superscripts can be assumed to pertain to relatively lean specimens (classes 0 to 1); in other cases, the average fat value (usually an approximation) for the sample determines the value of the superscript. For instance, the five immature female Cerulean Warblers were, on the average, "very fat." In some species fat condition was assessed by weighing subcutaneous fat, expressing this as percentage of body weight, and setting up a scale of values in which the McCabe classes were related to those based on relative amount of subcutaneous fat (Norris, 1957). In most examples, however, fat classes were determined in a visual, semi-quantitative way as has been done by McCabe (*op. cit.*), Wolfson (1945), and others.

Except for purposes of analysis of regional variation in weights of certain species (Table 5), we think it better to omit subspecific designations. In nearly all instances the geographic populations represented in a given sample in Table 1 refer to but one subspecies or race. Certain transients, such as the Northern Water-thrush, provide exceptions, but since data on these are very few they hardly warrant segregation as to race here. Furthermore, it has been demonstrated that insofar as fat migratory birds are concerned, weight variations attributable to subspecific differences are obscured by more pronounced variation in fat content (Johnston and Haines, *op. cit.*). For birds that breed in southern Georgia and adjacent parts of South Carolina, one can determine the geographic race by consulting Greene *et al.* (1945), Sprunt and Chamberlain (1949), Norris (1951), and Burleigh (1958). In this paper our principal aim is to present available data on weights of bird specimens taken in a rather limited geographic and physiographic region of the southeastern United States, without placing emphasis, except as noted above, on variation associated with different subspecies or geographic regions. It is probable that a number of studies in the future will focus on racial and regional variations in bird weights, as have in point of fact a number of studies already published (examples being Behle, 1943; Amadon, 1944; and Davis, 1951:6–8).

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Sex and Age Differences in Weights

As illustrated in Table 2, there were in most instances relatively small differences in weights attributable to sex. These are shown in terms of simple differences between mean weights, expressed as percentage of weights of males, and in terms of standard statistics, or *t*- and P-values. Judging from the latter values, only three of the species in Table 2, the Common Crow, Carolina Chickadee, and Red-bellied Woodpecker, seem to show decidedly significant differences of weights between males and females. As is brought out in a subsequent paragraph, Hartman's (1955) data likewise reveal important sex differences in weight of the two last-mentioned species, as well as the Hairy Woodpecker. Information provided by Baldwin and Kendeigh (1938:422) points up comparable significant sex differences in the Black-capped Chickadee (*Parus atricapillus*) and the Hairy Woodpecker. The difference between the male and female of the Brown-headed Nuthatch (Table 2) is not significant in the adult sample but is fairly significant in the sample of immatures. The female averages heavier, although not significantly so, in only one species, the White-eyed Vireo. This seeming "reversal" might have been due to the fact that changes in reproductive organs may add more to the "standard weight" of females than to that of males. Baldwin and Kendeigh (*loc. cit.*) list four species, the Catbird, House Wren (*Troglodytes aëdon*), Bob-white, and Robin (*Turdus migratorius*), in which females appear in late spring and summer to be significantly heavier than males. It may well be that these birds, like the White-eyed Vireo, undergo reversals of this sort only because of physiological changes associated with reproduction. This surmise is in fact supported in some degree by Stoddard's (1931: 75, 76) data on Bob-whites. Consequently, sex differences in weights of adults included in Table 1 may in some instances be minimized and may be expected to be somewhat greater, the females being relatively lighter, in samples obtained in the non-breeding season. It is also possible that heavy deposits of fat associated with migration tend to mask differences which would be more apparent in weights of more or less lean specimens. As reported by Tordoff and Mengel (1956:34) for birds killed in nocturnal migration, however, data for several species "indicate a generally greater weight of males than of females. . . ."

In comparing weights of males and females, Baldwin and Kendeigh (1938: 421) state that "after a careful examination of the data, an arbitrary limit of 3.0 per cent of the male's weight was selected as representing the lowest

TABLE 2
SEX VARIATIONS IN BIRD WEIGHTS

Species	Female: per cent difference from male	Degrees of freedom[1]	Significance of difference (*t*)	(P)
	(a) Adults			
Common Crow	—14.6	13	4.37	<.01[2]
Carolina Chickadee	—9.0	8	2.69	<.05[2]
Red-bellied Woodpecker	—10.4	11	2.59	<.05[2]
Cardinal	—3.2	16	1.29	.19
Mockingbird	—5.4	11	1.06	.27
Brown-headed Nuthatch	—2.6	27	0.96	.32
Rufous-sided Towhee	—3.2	16	0.75	.42
White-eyed Vireo	+2.3	12	0.58	.50+
	(b) Immatures			
Brown-headed Nuthatch	—6.6	15	1.72	.10[3]
Mockingbird	—4.7	10	1.36	.16
Yellow-throated Warbler	—3.4	9	0.80	.42

[1] Sum of number of specimens in pair of samples under comparison, minus one; **e.g.**, $N_a + N_b - 1$.
[2] Significant difference.
[3] Fairly significant difference.

amount of difference between the weight of the sexes that could be considered significant." It would seem that the validity of this arbitrary lower limit could be tested fairly adequately by establishing a relationship between per cent values thus derived from, say, samples A and B, and *t*- or P-values derived from comparison of the same samples. A relationship is suggested in Tables 2 and 3. If the data in these tables (excluding the Common Crow because of its unusually large size) are plotted as a scatter diagram, one can draw a line of regression which links, in approximate fashion, the per cent values with corresponding *t*-values. The approximate relationships for small samples (degrees of freedom ranging from 7 to 27) are as follows:

Per cent value	*t*-value	Per cent value	*t*-value
1	0.2	9	2.5
2	0.5	10	2.8
3	0.8	11	3.0
4	1.1	12	3.3
5	1.4	13	3.6
6	1.6	14	3.8
7	1.9	15	4.1
8	2.2	16	4.3

Assuming comparable variability, the larger the samples being compared, the

larger the *t*-values relative to the per cent values. As is evident from the P-values (Tables 2 and 3) corresponding to *t*-values, a rather high degree of statistical significance ($P = .10$ or less) pertains to sample pairs whose means differ by about 7 per cent (or more). It is our belief, then, that a difference between means of the sexes should equal or exceed 7 per cent, approximately, rather than 3 per cent, of the weight of the male if it is to be considered significant. This would seem to hold for small- to medium-sized passerine birds, except in cases of very large samples. Regardless of sample size, however, it would seem better (data permitting) to use standard tests of significance instead of more or less arbitrary per cent values in the assessment of weight differences in compared samples. The standard tests take into account not only differences between means but also both size and variability of samples, whereas the method employing per cent differences neglects the last-mentioned factors.

A number of workers have applied statistical tests to weight data. For example, Stegeman (1954) analyzed data from an unusually large series of winter-collected Common Starlings and found males to be heavier than females by a highly significant margin ($t = 10$). Baumel (1957), in comparing weights of male and female Fish Crows collected in Florida, provides both a *t*-value and a "coefficient of divergence," or per cent difference, using the former value ($t = 4.3$) as proof that the males are significantly heavier. In this respect the Fish Crow bears close resemblance to the Common Crow (Table 2). Hartman's data (1955) enable one to calculate comparable values for male versus female samples (age groups combined) in many species, including the Carolina Chickadee in Ohio ($t = 3.4$), Red-bellied Woodpecker in Ohio ($t = 5.0$), and Hairy Woodpecker in Maine ($t = 5.6$). We should like to emphasize the fact that Hartman's paper contains a wealth of statistical information, much of which will lend itself to further analyses, on both heart weights and total weights of Nearctic and Neotropical birds.

Whereas four out of 11, or 36 per cent, of the groups included in Table 2 display significant sex differences in weight (the males being heavier as a rule) only one out of 11, or 9 per cent, reveal significant age differences (Table 3). This rather pronounced age difference obtains in male Rufous-sided Towhees; a comparable weight difference in adult and immature towhees, the adults being heavier, is given by Baldwin and Kendeigh (1938: 423). In our samples, immatures average slightly heavier than adults in all but three groups (male towhees, male Red-bellied Woodpeckers, and female Brown-headed Nuthatches). By contrast, Baldwin and Kendeigh (*ibid.*) found immatures to average heavier than adults in only two species, the Cardinal and Catbird, the opposite being true of 16 additional species. Because our data are comparatively few, we cannot as yet be sure whether this seeming discrepancy, in which immatures tend to weigh more than adults, is

TABLE 3
AGE VARIATIONS IN BIRD WEIGHTS

Species	Immature: per cent difference from adult	Degrees of freedom[1]	Significance of difference (t)	(P)
	(a) Males			
Rufous-sided Towhee	—7.1	14	2.80	<.02[2]
Red-bellied Woodpecker	—6.2	10	1.17	.23
Blue Jay	+3.3	18	0.61	.50+
Yellow-throated Warbler	+2.4	7	0.57	.50+
Mockingbird	+1.8	13	0.53	.50+
Tufted Titmouse	+2.3	12	0.49	.50+
Brown-headed Nuthatch	+1.4	27	0.43	.50+
White-eyed Vireo	—0.8	15	0.26	.50+
	(b) Females			
Field Sparrow	+3.6	9	0.78	.42
Brown-headed Nuthatch	—2.8	15	0.56	.50+
Mockingbird	+2.3	8	0.41	.50+

[1] Sum of number of specimens in pair of samples under comparison, minus one; e.g., $N_a + N_b - 1$.
[2] Significant difference.

in fact a reality or whether it will become less evident, and thus accord better with Baldwin and Kendeigh's findings, after additional weights of southern birds will have been gathered and analyzed. Baldwin and Kendeigh (*ibid.*: 424) report other inconsistencies in published data on weights of adults as compared with immatures, pointing out that these "may indicate either a faulty method of analysis or an inadequate amount of data or both." We venture to add that samples, aside from being of adequate size, need to be comparable on seasonal and perhaps even sub-seasonal bases (taking into account, for instance, whether females are laying, how long immatures have been independent, or whether molting or migration are under way), if analyses are to embody sufficient refinements yielding valid and convincing results.

With respect to nocturnal migrants, it is of interest that Tordoff and Mengel (1956:34) indicate that in some species there is little difference in weight according to age, whereas in some others immatures seem to average a little heavier than adults.

VARIABILITY AND MONTHLY VARIATION IN WEIGHTS

Coefficients of variability (CV), as computed for all samples containing four or more individuals, are summarized in Table 4. The weights of males are on the average slightly less variable than those of females, but the difference between the sexes is not significant for either age group. The weights of

adults are a little less variable than those of immatures, the difference being fairly significant ($P = .10$) for both sex groups. The most variable samples pertain to more or less fat transients or pre-migratory birds (immature Cerulean, Hooded, and Kentucky warblers). Comparatively high variability is also shown by breeding female Rufous-sided Towhees ($CV = 10.4$) and by immature male Blue Jays ($CV = 12.4$) and immature male Brown-headed Nuthatches ($CV = 9.4$). The fact that adult females were on the whole only slightly more variable than adult males suggests that few samples, if any, were vitiated by unusually heavy, egg-laden individuals; this fact is further substantiated by data on breeding condition in our field catalogs. Group coefficients of variability, based on CV's for different species and computed for each of the four sex–age categories, were quite high (31.5 to 43.6). The lowest group coefficient pertained to the adult females (another indication of relative homogeneity in samples of this group), whereas the highest pertained to the sample of immature males.

TABLE 4

SUMMARY OF VARIABILITY OF BIRD WEIGHTS

Sex and age group	Number of samples (= number of species)[1]	Coefficient of variability	
		Average with standard error	Extremes
Male, adult	19	5.89 ± 0.25	2.58 — 9.96
Female, adult	11	6.18 ± 0.35	4.15 — 10.32
Male, immature	13	7.70 ± 0.87	3.35 — 14.94
Female, immature	7	8.50 ± 1.20	6.28 — 15.06

[1] Total sample includes 27 different species.

The high variability in some of the immatures is due in part to weight increase from June and early July to August. In this summer period the increase shown by young male Brown-headed Nuthatches is, for example, about 16 per cent. For young male jays it is about 10 per cent. On the basis of abundant data from many species of birds, Baldwin and Kendeigh (*ibid.*: 446), in connection with a searching discussion of monthly variation in weights, state that "the rapid rise in body weight from July to October is even more pronounced in the immatures than in the adults, 13.1 per cent compared with 5.2 per cent." According to these authors, this rise is due partly to maturing and partly to the same environmental conditions affecting the adults. It seems to us that the young of single-brooded or earlier nesting birds, as Brown-headed Nuthatches or Blue Jays, tend to show relatively sharp weight increases from June to August. Contrariwise, double-brooded or later nesting birds, as Cardinals and Rufous-sided Towhees, tend to show but small increases (if any at all) from early to late summer. An explanation would

seem to lie in the fact that a sizable sample of immatures of the last-mentioned species taken in middle and late summer would contain relatively more individuals that were recently fledged than would a sample of the earlier nesting species.

Regional and Racial Variations in Weights

For the eastern United States there have been few comparisons of weights involving northern and southern, intraspecific populations. Preliminary data on three species (the Blue Jay, Common Grackle, and Cardinal) have been assembled by Amadon (1944). In each species, particularly the grackle, the northern population or subspecies (represented by samples from Michigan and Ohio) averaged heavier than the southern populations (samples, mostly small, from Florida).

In most of the birds included in Table 5, the same sort of trend is evident. The Rufous-sided Towhee provides a noteworthy exception in that populations from the Coastal Plain of Georgia and adjacent parts of South Carolina are significantly heavier than those from Ohio and New England. The northern towhees represent the race *Pipilo e. erythrophthalmus*; the southern, *P. e. canaster* and *P. e. rileyi* (Dickinson, 1952:350; Norris, 1951:65). With other species in Table 5 we cannot be certain of strict seasonal comparability in all instances, but we believe most of the trends indicated will be borne out by subsequent comparisons involving series both larger and more exactly pinpointed as to season of collection. It is of interest that Cardinals from the Georgia–South Carolina region are not significantly lighter in weight than ones from Ohio, whereas those from Florida, as suggested by males, do appear to be significantly lighter. This correlates well with nomenclatural subdivisions of the species, inasmuch as Ohio, South Carolina, and Georgia (except the extreme southeastern part) are included within the range of *Richmondena c. cardinalis* (American Ornithologists' Union Checklist, 1957; Greene *et al.*, 1945), whereas peninsular Florida is occupied by *R. c. floridana* (Howell, 1932:438). Carolina Chickadees in Ohio may be referred to *Parus c. extimus* (cf. Lunk, 1952:15, 17). They appear to be significantly heavier than those collected in southwestern Georgia, where the population seems intermediate between *P. c. carolinensis* and *P. c. impiger* (Norris, 1951:19, 20). According to Burleigh and Lowery (1944), the Red-bellied Woodpecker is represented by the race *Centurus c. zebra* in Ohio and by *C. c. carolinus* in the eastern United States east of the Alleghenies (with an additional race *perplexus* in southern Florida). In this woodpecker the comparisons point to an inconsistency, with larger males but smaller females in the sample of *zebra* as compared to that of *carolinus* from the southern United States. Although this inconsistency may in fact exist, it may on the other hand disappear once larger, seasonally comparable samples are available for comparison. If the

data from Ohio reflect accurately the real situation, the dimorphism exhibited by male and female Red-bellied Woodpeckers in that region is indeed remarkable (the per cent difference in mean weight being almost 20 per cent). Two

TABLE 5

COMPARISON OF WEIGHTS OF NORTHERN AND SOUTHERN SAMPLES OF SEVEN BIRD SPECIES

Species	Region	Season (months)	Average weights in samples		Per cent difference from northern sample		Source of data[1]
Rufous-sided Towhee	Mass., Conn.	M:4:10; F:5–8	8M: 42.0	6F: 39.3			(1)
	Ohio	———	16M: 42.0	2F: 38.0			(2)
	Ohio	M:6–8; F:7–8	20M: 41.1	4F: 38.5			(3)
	Average		44M: 41.6	10F: 38.8			
					M(+9.4)[2]	F(+13.7)[2]	
	Ga., S. C.		11M: 45.5	6F: 44.1			(x)
Cardinal	Ohio	6–8	11M: 41.2	14F: 39.2			(3)
					M(—4.6)	F(—3.1)	
	Ga., S. C.	6–8	7M: 39.3	10F: 38.0			(x)
					M(—8.2)[2]	——	
	Fla. (penin.)	——	4M: 37.8	——			(2)
Carolina Chickadee	Ohio	——	13M: 10.6	24F: 9.8			(2)
					M(—11.3)[2]	F(—12.2)[2]	
	Ga.	7–8	5M: 9.4	4F: 8.6			(x)
Red-bellied Woodpecker	Ohio	——	9M: 76.0	10F: 61.4			(2)
					M(—3.8)	F(+6.7)	
	Ga., S. C.	7–8	6M: 73.1	6F: 65.5			(x)
Downy Woodpecker	Ohio	7–8	——	19F: 24.8			(3)
					——	F(—14.1)[2]	
	Ga.	7–8	——	4F: 21.3			(x)
Eastern Wood Pewee	Ohio	——	8M: 14.2	——			(2)
					M(—2.8)	——	
	Ga.	6–8	4M: 13.8	——			(x)
Red-winged Blackbird	Ohio	——	——	7F: 43.0			(2)
					——	F(—17.2)[2]	
	Ga., S. C.	7–8	——	4F: 35.6			(x)

[1] Sources: (1) Wetherbee, 1934; (2) Hartman, 1955; (3) Baldwin and Kendeigh, 1938; (x) this paper.
[2] Differences considered to be significant.

subspecies of Downy Woodpecker, *Dendrocopos p. medianus* and *D. p. pubescens*, respectively, are involved in the northern and southern samples (American Ornithologists' Union Check-list, 1957; Greene *et al.*, 1945). Similarly, populations that may be designated *Agelaius p. phoeniceus* and *A. p. phoeniceus* x *mearnsi* figure in the compared samples of Red-winged Blackbirds (Hartman, 1955; Norris, 1951:25). Significant weight differences are apparent in both these species. The Eastern Wood Pewee is not subdivided into geographic races and seems to vary only slightly in size from more northern to more southern regions.

Most of the samples in Table 5, as well as those treated by Amadon (1944), tend to support "Bergmann's rule," which holds that in species with extensive geographic ranges the size of individuals, which is reflected by their weights, tends to be greater at higher latitudes and altitudes (colder regions). The fact that towhees form a rather conspicuous exception appears to be tied in with the apparent hybrid origin of the *canaster–rileyi* complex (cf. Dickinson, 1952:334, 340). Most of the northern and southern samples which show significant contrasts in weight represent distinct, nomenclaturally-recognized geographic populations or races. Hence certain racial differences, which in the past have been based principally on differences in color, color pattern, or linear measurements, are gaining support, if only in small measure, from preliminary sets of data on weights.

Summary

Statistical data are presented on weights of 576 specimens representing 97 species of birds. All were collected in summer, from 1947 to 1956, in southern Georgia and adjacent parts of South Carolina. The general procedure and manner of presentation of data are explained. The data are broken down into three categories: species, sex, and age (adults versus fully fledged immatures). For each category represented by more than one weight, the mean value with the standard error is given both for weight and for sub-seasonal period of collection. For more or less fat specimens, semi-quantitative indications of fat condition are provided; these aid in the interpretation of certain weight values. Data for certain species are subjected to further analysis. In four species, males are significantly heavier than females; in four others there is no significant difference between the sexes. By our criterion (the validity of which is discussed), the difference between the means of compared samples, if it is to be regarded as significant, must equal or exceed 7 per cent of the weight of the male, or the difference must show a P-value that is no greater than .10. Among compared samples, immatures in most instances average slightly heavier than adults. The coefficients of variability of weight samples, if compared sex for sex, are on the whole significantly higher ($P = .10$) for immatures than for adults. This marked variability is due in part

to increase in weight of young birds from early to late summer, a phenomenon well demonstrated by Baldwin and Kendeigh (1938). Northern representatives of seven bird species tend to weigh more, in some instances significantly more, than southern representatives of the same species. An exception is provided by the Rufous-sided Towhee, in which specimens from our series are significantly heavier than ones from Ohio and New England. This may be due to the hybrid origin of the southern population (Dickinson, 1952). In several species in which the northern birds are significantly heavier than the southern, the compared populations represent different subspecies or geographic races.

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A NESTING OF THE ACADIAN FLYCATCHER

BY DONALD L. NEWMAN

FROM June 12, 1954, when I discovered the partly-completed nest, until August 8, when I last observed a lone bird, I watched the nesting and post-nesting activity of a pair of Acadian Flycatchers (*Empidonax virescens*) whose breeding territory was located in a small second-growth woodland in Cleveland Heights, Cuyahoga County, Ohio.

In all I made 60 individual visits to the area on 53 days, of which 49 days were consecutive. Out of the approximately 61½ hours of observation, 38¼ hours were spent at the nest site whereas the remaining time was devoted to seeking and watching the young after they left the nest. By necessity most observations were made in the evening between 7:00 and 9:00 p.m., but the birds were also studied during the day on week ends; and at the approach of critical periods (egg-laying, hatching, and departure from the nest) I made brief visits to the nest each day shortly before 8:00 a.m. The earliest observation was at 7:25 a.m., the latest at 9:25 p.m. Eastern Daylight Time. The nesting observations were made without a blind from a distance of 12 feet, with the aid of 8 x 30 binoculars.

The woodland in which the nest was located lies in a flat valley approximately 300 feet wide through which a shallow brook snakes its way. Above the steep slopes to the north and south there are broad boulevards beyond which there are imposing suburban homes. On the north side of the brook there is a fairly dense understory, but on the south side all the undergrowth has been removed, creating a sharp contrast between these two thin slices of woodland. The flycatchers confined themselves almost entirely to the shaded north side where there is a dense growth of sapling trees.

Red oaks (*Quercus maxima*), some of them 60 or 70 feet tall, predominate on the north slope and on the flat border to the edge of the boulevard, although there is also a scattering of beech (*Fagus grandifolia*), tulip (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), and American elm (*Ulmus americana*). Witch hazel (*Hamamelis virginiana*) grows luxuriantly on the slope and in the valley as well. Sharing this strip of woods with the Acadian Flycatchers were Red-eyed Vireos (*Vireo olivaceus*), a pair of Eastern Wood Pewees (*Contopus virens*), Scarlet Tanager (*Piranga olivacea*), Tufted Titmouse (*Parus bicolor*), Wood Thrush (*Hylocichla mustelina*), Black-billed Cuckoo (*Coccyzus erythrophthalmus*), and Robin (*Turdus migratorius*). Common Crows (*Corvus brachyrhynchos*) and Blue Jays (*Cyanocitta cristata*) occasionally visited the area.

NEST-BUILDING

When I discovered the nest on the afternoon of June 12, it was largely

completed, the sides and rim seemingly finished but the bottom thinly woven with much light showing through. The nest was located at the outer end of a forked branch of a witch hazel bush which grew half-way down the steep north slope, and about 75 feet from the brook. By a happy chance it was easily seen from the path at the top of the slope, only about 12 feet distant. Shading the nest, which consisted of the customary loosely-woven fibers of wild grapevine bark and other fibrous strands, was a single leaf attached to a short twig on each side of the forked branch from which the nest was suspended. And from the bottom hung a streamer of grapevine bark some 8 inches long, which the flycatcher never incorporated into the nest.

Although on the first day I spent only a brief time watching the construction of the nest, on the following day, June 13, I devoted one-and-one-quarter hours in the morning observing the building activities. During this time the female made a total of 22 visits to the nest, or an average of one trip every four minutes. (In the absence of any physical characteristics to distinguish the male from the female, I must assume that all of the nest building was done by the latter, and this assumption seems to be borne out by the repetitive pattern of activity as well as by the call notes peculiar to the female, which notes I did not learn until later.) On my arrival at the nest site at 9:40 a.m., the female was absent but she soon appeared and entered the nest where she began to mold by pressing against the sides with her breast, making several 90-degree turns as she moved around the inside of the cup. She then turned her attention to the bottom on which she pressed with great vigor, tipping far forward so that her tail was at a right angle to the rim of the nest. Finally, before departing, she adjusted and drew in fibers attached to the rim. The male, nearby but out of sight, kept repeating a single call note, *wert*, and continued to call off and on for the next six minutes, during which time the female returned to the nest just once to resume her molding movements and the adjusting of the nesting material.

At 9:58 one of the flycatchers—seemingly the male—began to call in a loud, excited manner as the result of the appearance of a female Brown-headed Cowbird (*Molothrus ater*) which perched in an oak tree overlooking the nest site. Although the flycatcher flew directly at her, the Cowbird held her perch but soon departed, leaving him (?) to utter his single note for a minute or two more after which he lapsed into silence. He was not heard or seen again that morning, except for his *ka-zeep* song which he sang just once at 10:04, close to the nest on which the female was then working. It has been clearly shown by Brandt (1947:79) that the Acadian Flycatcher is sometimes parasitized by the Cowbird, with the young of the latter being successfully fledged.

The morning's observation revealed that the female had a definite pattern of activity. Whatever material she was gathering (I could never see anything in her bill even with

my binoculars), she obtained from or near the ground at a distance of not more than 150 feet from the nest, going and coming along the fairly densely grown slope to the east of the nest or occasionally to the tangles of wild grapevine along the border of the woods. With but three or four exceptions, she did not fly directly to the nest but instead paused first for from 10 to 30 seconds either in a witch hazel bush lower down on the slope or in one adjoining the nesting site to the east. Sometimes, however, she would perch momentarily in her own bush and then fly directly to the nest to continue her molding and binding, for that is what she was evidently doing when she reached out to pull in loose strands which she proceeded to work into the nest.

In going to and from the nest and while working on the nest, the female usually called frequently—a single note with always the same inflection. This note appears in my field notes variously as *whit*, *pit*, *wert*, and *swert*, but it is probably equally well transliterated as *peet*, which is the spelling chosen by Saunders (1951:86).

When I made a brief inspection at 7:45 a.m. on June 14, the female, which was calling nearby, came to the nest for a moment and then flew away; the male was calling from down in the valley. On the morning of the 15th and 16th I did not see either bird but did hear them during my few minutes' stop in the woodland where I examined the nest, finding it still empty. On none of these three days was I able to discover by hasty examination whether any additional work had been done on the nest.

Egg-Laying

I discovered the first egg in the nest on the evening of June 17. But as I had not visited the nest since the morning of the 16th, I had no way of knowing on which of the two days the egg was laid. At 7:30 a.m., June 18, a second egg was in the nest. The third and last egg completed the clutch on June 19, though I cannot be certain it was actually laid that day because I failed to visit the nest on the preceding evening to ascertain the number present at that time.

Incubation

For one hour and 20 minutes in mid-afternoon of June 19 I watched as the female began to incubate. (Insofar as I could determine the male did not participate in incubation.) She was absent when I arrived, but appeared seven minutes later to flycatch in the understory in the immediate vicinity of the nest site. Then she perched for a moment about 15 feet away, and then she flew directly to the nest, settling down rather high with head and bill raised so that she could look about, which she did frequently. During the next 70 minutes she left the nest four times to feed in the understory or along the brook. She seemingly did not go more than a few hundred feet, judging by the sound of her *wert* notes, uttered from time to time during her absence as well as upon her return. On one such absence a Blue Jay flew into the treetops to skulk about, seemingly in search of eggs. Thereupon one

of the flycatchers, quite certainly the female, began to call loudly though at some distance from the nest and continued to do so all the while the jay stayed in the area, and even for a few minutes after this prowler departed. Finally, having been gone for about 22 minutes, the female returned to the nest, uttered several *wert* notes, and settled down though looking about alertly.

A little later in the afternoon, almost immediately after the female's return to the nest following a five-minute absence, the male appeared to perch about two feet away on the very branch to which the nest was attached. He uttered two low, exquisitely soft, warbled phrases, *pee-tul, pee-tul,* to which his mate failed to respond and he quickly flew away. Shortly thereafter he sang his *ka-zeep.*

According to Bent (1942:190), "the period of incubation, as observed by Harold M. Holland . . . is 13 days," but my particular flycatcher incubated for 14 full days, from June 19 through July 2, the eggs hatching on the following day. During this period I spent some 17½ hours at the nest site where it soon became evident that the female had certain fixed patterns from which, however, she not infrequently deviated. These habits or routines were related to four principal activities: (1) her position while incubating; (2) her departure from the nest; (3) her return to the nest; (4) resumption of incubation.

(1) *Position while incubating.*—The branch of the witch hazel in which the nest was located grew on the outer side of the bush away from the slope so that the apex of the fork to which the nest was attached pointed inward toward the slope. When she was incubating, the female either sat facing the slope with her head at the apex of the crotch or sat roughly parallel to the slope; on only three occasions do my notes indicate that she sat facing away from the slope and looking out over the valley. The high canopy of oaks kept the sun from penetrating the understory, which was largely in shadow during the day, but was brightly illumined for brief periods in the evening by searching fingers of light from the slowly-setting sun. During these minutes of illumination she always sat facing away from the sun, but on one occasion during the tenth day of incubation she left the nest while it was spotlighted by the sun's rays and was absent for eight minutes, returning after the nest was again enveloped in shadow. Throughout the entire 14 days of incubation she was highly alert, frequently looking from side to side or inspecting the leaves overhead and occasionally peering down over the side of the nest. In the early stages and again in the late stages of incubation, she was quite restless and shifted her position frequently, sometimes rising onto the rim of the nest to look inside and, seemingly, to reach in to move the eggs.

(2) *Departure from the nest.*—When she left the nest, which she did without making any vocal utterance, the female, with but one exception on the first day of incubation, invariably departed from the east side of the nest close to the apex of the fork. At times it appeared that she sprang *up* and off through the combined use of her wings and feet, whereas at other times she seemed to pitch off over the side, and with set wings would glide down to the base of the slope and on through the understory to the east to a distance of perhaps 85 to 150 feet. Not infrequently, however, she would simply drop to the base of the slope where she would perch for a moment and then move on to flycatch in the more open woods beyond or along the near bank of the brook. Only once

during the incubation period did I observe her feeding in the wooded border above the slope, and on that occasion she had first flown off along the slope to a distance of about 85 feet and then had worked her way up and back through the border of the woods.

On the morning of the second day of incubation she suddenly left the nest to fly to a tangle of dead branches lying on the slope about 30 feet away where she snapped up an insect and immediately alighted on one of the branches in order to swallow her prey, after which she returned to the nest in a moment to resume incubation. This was the sole instance of this unusual behavior.

It was not uncommon for the female to leave the nest after 8:30 p.m., when the woods was already cloaked in a dim half-light, to flycatch in her customary area. Her latest hour of departure was recorded on the twelfth day of incubation, June 30, when she flew off at 9:10 p.m., the sun having set although the western sky was suffused with the afterglow. Although I waited until 9:25 p.m. I could not detect her return in the darkness which now enveloped the woods, and at that late stage in the incubation period I was unwilling to go down to the nest for fear that my intrusion would in some way interrupt the nesting activity.

(3) *Return to the nest.*—After the female left the nest to feed she usually remained silent for several minutes but sometimes she started to call *wert* just seconds after her departure, continuing to call for a minute or two and then lapsing into silence. Her return to the nest was made gradually, in stages, and was almost invariably accompanied by much calling, sometimes continuous but more often fitful. Coming back through the understory at or just below the base of the slope, the female would drop into a large hazel bush at the foot of the slope and about 12 feet below the nest site. From there she would advance to a second hazel bush just to the east of the nesting bush, pause for 15 to 30 seconds, and then fly directly on to the nest; rarely she would perch for a moment in the nesting bush itself before flying on to the nest, thus adding a third stage to her return. There was a certain branch in the second hazel bush which she favored, and at times it seemed she alighted on the exact same spot. Not always, however, did she keep to her routine, for not uncommonly when she paused in the hazel bush at the bottom of the slope she sallied out after insects and then resumed her bush-by-bush approach to the nest. Even on those rare occasions when she returned to the nest along the upper half of the slope, coming through the oaks at a height of 12 to 15 feet, she always dropped into the witch hazel at the base of the slope and worked her way back up. The only marked deviation from this habit pattern occurred on the evening of July 1, the 13th day of incubation, when the female, which had been feeding along the brook, came onto the nest in what my notes describe as "a long upcurving glide which seemed to originate outside of the cover of the hazel bushes but carried her in and thru."

Judging by the sound of his voice, the male sometimes joined the female when she left the nest to flycatch, but only once during the incubation period, on the afternoon of June 26, did I actually see the two together. On that occasion they were darting out from a beech tree overhanging the brook, about 100 feet from the nest. A few moments later the female perched in the second hazel bush where she was soon joined by her mate which executed a brief flight about her while uttering the sweet *pee-tul* phrase. He then flew away and she settled on the nest without uttering a note, but in a moment he sang his *ka-zeep* close by, repeating it two minutes later from a perch along the brook.

(4) *Resumption of incubation.*—Upon returning to the nest the female would utter a sharp, incisive *wert* either just a moment before alighting or more commonly at the precise instant she settled on the nest. Out of the 35 returns to the nest which I observed

during the incubation period, only twice did she resume her position on the nest without uttering a sound. Usually the first emphatic *wert* (or *wist* or *wirst* as it sometimes sounded) was followed by from two to perhaps six more subdued notes which were muttered rather than enunciated crisply. Sometimes, however, she would call at great length, as on the evening of June 25 (the seventh day of incubation) when she uttered 44 *wert* notes in all, at about three-second intervals, until a loudly cawing Crow flew into the woods to perch in the crown of an oak overlooking the nest. Thereupon the flycatcher ceased her calling and did not resume even after the Crow's departure a minute or so later. On the morning of the second day of incubation, after an absence from the nest of 2½ minutes, the female returned and called *wert* 14 times, the first few notes at intervals of several seconds with the speed gradually decreasing until at the last the calls were 10 seconds apart. On several other occasions she called for periods of from two to three minutes, her voice becoming softer and gradually dying away.

While this calling by the female during her return to the nest and immediately upon her alighting may have been a signal to her mate, the male did not utter any responsive call and, indeed, he was usually silent when the female was calling on her flight back to the nest; nor was he heard on those occasions when the female called at great length after resumption of incubation.

Hatching

Upon my arrival in the woodland at 1:45 pm., on July 3, the female was on the nest and the male was singing his *ka-zeep* from the trees on the slope to the east of the nest. Five minutes later she left the nest and I hastened down to discover that it contained two young just hatched, the third egg unhatched but scored around the center, and the half of an empty shell. The two nestlings, naked except for a bit of white down on the crown and the median line of the back, were a dull pinkish color and were about the size of a large jelly bean. Their eyes, extremely large in proportion to the head and body, were covered with a black membrane that gave the birds a grotesque appearance, indeed.

It was not until 4:32 p.m. that I again inspected the nest, when the female left to feed, and discovered that in the intervening 2¾ hours the third egg had hatched—the last nestling, pinker than the other two, seemingly just emerged, though not yet fully out of the shell, which was split in half. The half of the other shell was still present, too. Simultaneously with the return of the female a brief shower of rain broke suddenly, causing me to depart hastily from the nest, fearful that the unprotected nestlings might be harmed by the pelting drops. Nor did I revisit the nest later that day.

On the afternoon of the day the eggs hatched, the female spent the larger part of her time brooding the young, and she left the nest only seven times in 2 hours, 47 minutes for periods ranging from 30 seconds to as much as 13 minutes. On her departure from the nest she was utterly silent but during her return she called *wert* frequently as she followed the flight pattern she had established during the incubation period. Twice during the afternoon after settling down to brood, she uttered a long series of *wert* notes,

once consisting of 29 repetitions, the second time of 20 repetitions, the final notes in each series much weaker and at greater intervals than the first dozen notes. For the first time, too, she uttered a new note: a drawling or slurred and rather plaintive *suh-ree*, which she called once while on the nest and again about 45 minutes later just as she flew off the nest.

In addition to being more restless and alert, possibly the natural consequence of her new responsibilities, the only appreciable change in the habits of the female was that she did not go as far from the nest to flycatch, usually remaining within a radius of about 75 feet. On one occasion (2:16 p.m.) she darted off the nest to a distance of perhaps four feet and then dropped to the hazel bushes at the bottom of the slope, but in a moment she returned to the nest with something blackish in her bill. Standing on the rim she worked this catch in her mandibles and then appeared to feed just one of the two young, after which she settled down high on the nest and facing west. On another occasion about an hour later she flew off toward the side of the slope, hovered in the air while she snapped at a flying insect, and again dropped to the bottom of the slope to continue her flycatching for two minutes. Then she returned to the nest and apparently fed both young.

Only once during the time I watched did the female display any special interest in what was going on within the nest. At 3:27 she arose from her brooding position, stood on the rim, and, bending down, moved her head and bill about inside the nest in the area where the unhatched egg was lying. Most of the time, however, she was sitting so that her breast was seemingly in direct contact with the egg rather than with the bodies of the newly-hatched young.

The male apparently played a minor role on the day the eggs hatched because he was not seen at the nest or near the immediate nest site, but he did sing his *ka-zeep* frequently and called *wert* emphatically for many minutes at a time. At 3:57 both birds were calling from along the brook where I glimpsed the female flycatching. I suspect she was accompanied by her mate because a few minutes later they had moved into the trees on the slope though on opposite sides of the nest site and 100 to 125 feet apart, both birds calling vigorously, the male even introducing a single *ka-zeep*.

Later in the summer I found fragments of egg shell on the narrow path along the edge of the slope about 80 feet beyond the nest, and in the woodland border some 150 feet distant I found a complete half shell lying on the ground. Both were unmistakably portions of the eggs of the Acadian Flycatcher.

Care and Feeding of Nestlings

During the 13 days the young occupied the nest, the female was responsible for the larger part of their care, both brooding and feeding. The male did no brooding whatever, at least during the 15 hours, 11 minutes I watched the nest, but he did assist in the feeding of the young, albeit in a fitful and irregular fashion. Out of a total of 200 trips to the nest made by the parent

birds collectively, the male made only 36 trips, or 18 per cent. Yet on only half of these trips was it clear that he fed one or more of the nestlings, while in one instance he fed his mate. Thus there were 17 times when he simply came to the nest, perched momentarily, and then flew away. It is quite possible, however, that on these occasions the young were surfeited and gave no begging response, without which the male was not stimulated to transfer the food he may have carried in his bill (see Herrick, 1935:290). This assumption seems to be borne out by the record for July 11, the ninth day of nest life, when in four out of the five non-feeding visits by the male, the female had fed one or more nestlings within two minutes or less just prior to his arrival.

On exactly half of his 36 visits to the nest the male uttered his sweet, warbled *pee-tul* phrase either just before or as soon as he alighted. On 21 occasions the female was absent from the nest when he arrived, and only on six of these occasions did she return after he had called.

On July 4, the second day of nest life, during 1¾ hours of observation the male came to the nest just once. His mate had fed one nestling and had settled down to brood when he alighted in the nesting bush on a branch about two feet distant from the nest. He uttered the low, sweet *pee-tul* phrase and within a few seconds flew to a twig which placed him within reach of the female. Again he uttered *pee-tul* but she gave no response, and after 30 or 40 seconds he flew off.

Not until the third day of nest life did I actually see the male feed the young. On two visits in less than a minute (both times while the female was away) he perched on the rim, looked in the nest, yet did not feed. About one hour later he reappeared on the nesting branch and uttered a soft *pee-tul* whereupon his mate flew off. But again he merely looked into the nest, did not feed, and immediately departed. In a few seconds, however, the female returned and while she was feeding the young, her mate also returned, uttered his customary phrase, and when she left he, too, made a quick feeding jab at one of the nestlings. It was on that same day that the male after advancing to the rim of the nest paused a moment and then fed the brooding female.

During the first few days of nest life it appeared that the male's activities were not harmonized with the female's, and he seemed a stranger to and uncertain of his parental role. Gradually, however, his seeming confusion wore off while more and more his efforts to provide food for the nestlings blended in with those of his mate. Later, as the needs of the young increased, the parents sometimes appeared at the nest together, perching on opposite sides and feeding the nestlings either simultaneously or successively.

In the first few days following the hatching of the young, the female held largely, though not as consistently, to the pattern established during the incubation period. Thus she usually uttered the *wert* note immediately after departing from the nest (which she

had not done before), during the course of her return, and upon resuming brooding. Generally, too, she returned to the nest along the same route she had followed earlier, using the same stopping places in the witch hazel bushes. Sometimes, however—and this became increasingly evident as the nestlings grew larger and more demanding in their food requirements—she came directly to the nest without any intermediate stops and without uttering any calls whatsoever. She also began to enlarge her feeding area, even in the first days of nest life, to include the wooded border above the top of the slope where I had not seen her feeding previously. Only rarely did she do any flycatching along the slope to the west of the nest. Her feeding area was probably not more than 200 feet from the nest site in any direction, with most of her flycatching done to the east, especially along or near the brook.

When brooding, the female generally faced in toward the apex of the crotch which held the nest. She was always alert, often peered about, and on a few occasions darted directly off the nest to snap at a flying insect and then flew on to continue her feeding elsewhere. Although it was impossible to discover the identity of the insects captured, I did notice, particularly in the later stages of nest life, that the parent birds sometimes had crushed or amalgamated their tiny insect prey into ball-shaped masses about the size of the head of a safety match. On two occasions, however, their prey—seemingly a cranefly (Tipulidae) with transparent wings at least one inch long—could not be reduced to a form acceptable by the young. In the first instance, in July 9, the sixth day of nest life, the female arrived at the nest with the insect in her bill but was unable to compress the long wings. Upon failing to jam the insect down the throat of one nestling, she attempted to work her catch about in her bill in order to break up the wings, but after four more attempts to feed it to her nestlings she gave up and flew off with the oversized morsel still in her bill. The next day the male, which had come to the nest while my attention was diverted, flew off carrying a similar large insect in his bill and perched on a dead branch of a nearby oak where he labored with the insect, trying to break up the stiff, membranous wings by rubbing them against the wood. Failing in this, the bird flew back toward the nest, suddenly veered off, and disappeared from view with the insect still in its bill.

Despite my closest attention, only once was I able to detect either bird carrying off the fecal sacs deposited in the nest by the young. Yet judging from their frequent examination of the interior, nest sanitation seemed to be a responsibility of both parents, with the female, of course, assuming the larger share of the work. On a number of occasions I observed her pick up and swallow a fecal sac, especially during the first several days after the hatching of the young. Once, on the eighth day of nest life, when both parents were perched at the nest and apparently fed the nestlings, the female picked up a fecal sac and gave it to the male which swallowed it immediately.

On the evening of July 14, the eleventh day of nest life, a storm threatened. The sky grew black, the wind rose, and thunder crashed in the distance. Since the young now fully occupied the nest, which was lightly tossing about, the female stood at the high side near the apex of the crotch without actually brooding them. The wind gradually intensified, thrashing the treetops about and sending showers of twigs and dead branches to the ground. As the fury of the storm mounted, the nest began to sway and pitch in ever-larger arcs until finally with the edge of the storm almost overhead the female moved to the outer rim or low side of the nest, where her weight helped to stabilize the tossing structure, and leaned in and over the nestlings so as to shelter them with her

body. Fortunately, the storm soon passed on, only a little rain fell, and within 30 minutes the sky had begun to clear.

A comparison of the food-supplying visits of the parent birds will reveal how greatly the needs of the young increased as they neared the fledgling stage. Thus between 10:03 and 11:03 a.m., on July 4, the first day after hatching, the female brought food to the nest just three times, the male not at all. In the same one-hour period on July 11, the eighth day of nest life, the parents brought food a total of 12 times: the female on eight separate visits, the male on four.

Although I looked into the nest at least once each day, I spent only a moment there and made no attempt to examine the birds in order to study the development of their plumage. I was interested, however, to find that even on the first day after hatching when I pressed my finger on the rim of the nest, the nestlings—unlike those of other passerine species—failed to give the food response consisting of stretching out their necks and opening their bills (see Herrick, 1935:281). Instead, they remained huddled in the bottom of the nest—mute, immobile, and of course, blind. I noted that their eyes were open on July 8, the fifth day after hatching, but this did not affect their response and they continued to the end of nest life to remain absolutely inanimate whenever I looked in on them. This behavior may have been stimulated by the alarm notes of the female which always perched nearby—sometimes only five or six feet away. Her excitement frequently brought the male into the scene. He uttered the *wert* note with even greater sharpness and when highly excited, as on the last two days of nest life, broke into his *pee-tul* song. On the twelfth and final day of nest life, my appearance at the nest caused one of the parents to fly within three or four feet of me, snapping its bill loudly.

Not until the fourth day after hatching could I observe from my vantage point any movements of the young in the nest. On the evening of the next day one nestling was sitting upright, its head above the rim of the nest, and its eyes open. That same evening all three young were first seen to reach up and beg for food whenever either parent appeared at the nest. Later in the evening by dint of much straining and stretching they managed to rest their chins on the rim of the nest. The female continued to brood, though in ever-shorter periods, at least through the morning of July 11, the eighth day of nest life, when the three young almost filled the nest to the top. The next evening I first heard them utter a faint lisping cry immediately after the female left the nest; thereafter they sometimes buzzed in a subdued chorus when they were about to be fed and for a moment afterward.

Departure from the Nest

At 7:55 a.m., on July 16, when I visited the woodland to see whether the

young had left the nest, I could see only one nestling sitting upright. Thinking that the other two had already left, I bent the nesting branch down toward me to get a better look. Suddenly all three young "exploded" from the nest, fluttered to the ground at the base of the slope, and at once were lost to view against the leaf litter. Because I was fearful of stepping on them I made no search, but left the woods quickly with the alarmed notes of the adults sounding in my ears.

A few minutes after 7:00 that evening I returned to the woods and immediately heard the voice of the female as well as the peeping or *pseep* of one young bird whose whereabouts at first I could not discover. By carefully working up the slope near the nest site I eventually found this bob-tailed fledgling—obviously a runt—perched about 1½ feet from the ground in a fallen branch lying at the base of an oak tree and only some 20 feet from the nest site. The male parent, which had been calling *wert* emphatically nearby, was apparently unwilling to feed the fledgling because of my presence. I therefore moved on in search of the other two young and soon succeeded in finding one perched about 3½ feet above the ground in a sapling near the brook and perhaps 175 feet from the nest site. When I approached too close, this bird abruptly flew off in a perfectly straight line disappearing in the understory on the slope.

Returning to the runt fledgling, which was calling *pseep* repeatedly, I found that it had moved into a sapling oak adjoining the large oak and was perched three feet off the ground. It was then 8:30 p.m. and darkness was fast enveloping the woods making further observation impossible.

Prior to their departure from the nest, I was unaware that one of the nestlings had been receiving less food than the other two.

Post-Nesting History

At 10:23 a.m., on July 17, when I returned to the woodland, I discovered the runt perched in full sunlight on the very branch of the oak sapling where I had last seen it the night before. During the following 45 minutes the female, which was utterly silent, fed this fledgling eight times while the male provided just one feeding. He remained in the vicinity, however, and from time to time uttered either his *ka-zeep* or his sharp *wert* note.

Between feedings the runt, which kept up an intermittent peeping, fluttered its wings, stretched its neck, and occasionally flitted from twig to twig in the oak sapling but moving only a few inches at a time. Because of its stubby tail its balance was poor, and it tended to pitch forward when it alighted. At length it resumed its original perch in the sapling and, after much peering about, fluttered forth only to fall to the ground. It soon reappeared, perching on a fallen branch near the base of the tall oak, then moved to the base itself, and finally launched into the air headed toward a sapling some six feet distant. But the runt failed to gain sufficient altitude and fluttered to the ground about two feet short of its objective. Later in the morning and again in the afternoon

I found this bird perched low in a wild grapevine tangle, on one occasion being fed by the female.

The two other fledglings were not discovered until mid-afternoon of July 17 when I located them perched side-by-side about three feet from the ground on a dead fallen branch, not far from where I had seen the second fledgling the previous evening. They were quite obviously larger, more fully feathered, and longer-tailed than the lone fledgling, and were more proficient at flying. The female fed them frequently, but later when they had flown to another part of the woodland I believe the male joined in the feeding.

On the morning of July 18, the third day out of the nest, I watched two of the young continuously for one hour and 45 minutes as they perched side-by-side about six feet off the ground on a fallen limb which lay in a small opening among a stand of tall trees. The one bird was obviously the runt, being smaller and less vigorous than its fellow. Although a pattering of rain fell for a few minutes, neither bird showed any reaction nor did either one move from its perch throughout the entire 105 minutes of observation.

Feeding periods alternated with periods of passivity, the smaller bird mute and withdrawn though the larger fledgling sometimes preened, stretched its wings, extended itself to its full height, and once even uttered a few *tseep* notes. The male parent fed these two young a few times, once appearing simultaneously with the female so that the fledglings were fed successively. But the female was the major food provider, and in the time I watched she made no fewer than 43 food-carrying trips to the young. Her most intense period of feeding was between 11:45 and 12:05, when she made 21 feeding visits, or about one per minute. So fast did she arrive and depart that I often was unable to manipulate my binoculars (I was standing about 40 feet distant), my pencil, and notebook quickly enough to discover and then record which fledgling was fed. Of those feedings I was able to record, 26 involved the larger fledgling, 11 the smaller bird, with six marked "undetermined;" these last being so rapid I could not positively say which of the two young received the food.

Not only did the larger bird have the advantage of size, giving it a higher reach, but also it was simply more aggressive and demanding than its fellow. Thus in one seven-minute period involving a total of nine feedings, the larger bird was fed eight successive times, with the female on at least three occasions alighting next to the runt but then reaching past it to give the food to the other bird.

Although I had neither seen nor heard the third fledgling at any time during the morning of July 18, I discovered it just at noon as I was about to leave the woodland. It was perched in a sapling about 150 feet distant from the other two, and it was being fed by the female.

Beginning July 19, and continuing through August 2, which was the 18th day out of the nest, the three fledglings kept together in the woods, always remaining within a radius of about 350 feet of the nest site. Frequently they occupied the same treetop, bush, or sapling and often perched three in a row. At times they were extremely noisy, keeping up an almost constant "tseep-

ing," while at other times they buzzed only as they were about to be fed and for a moment afterward. As early as July 21, they uttered the *wert* note but not as forcefully as did the adults; by July 26, however, their *wert* notes were indistinguishable from that of the female. Unlike her earlier habit of uttering her call note upon her return to the nest to feed the young, the female upon her approach to the fledglings was utterly silent but occasionally voiced a single *wert* as she left them.

By July 24, the ninth day out of the nest, the fledglings, except for their rather stubby and uneven tails and quite yellow bills, appeared identical to the adults; yet they were not flycatching on their own or even, it seemed, making trial sallies after insects. Indeed, while perched on a limb overhanging the brook, they completely ignored a cloud of tiny insects which hovered right in front of them. The female was still feeding them, and in a 10-minute period just at noon she made six feeding visits. On the morning of the next day, however, one of the young appeared to be flycatching on its own, while I clearly saw another fledgling leave its perch and fly to a nearby limb to snatch a slow-moving caterpillar. The following evening, July 26, all three young were making sallies from three to six feet out from their perch, though it was impossible to determine whether they actually caught the tiny prey they snapped at.

The evening of July 29 was the last time I definitely observed the female feeding the young (just two), and all three were then making feeding flights on their own. Yet on the morning of August 1, two fledglings were perched high in the crown of a tall tree when a third bird (presumably the female) arrived and put its bill toward one of the other two as if to feed it. The second bird opened its bill but the distance and position of the birds prevented my seeing whether any food was actually transferred. Quite obviously, however, the food response had not entirely disappeared. On my last day of observation, August 3, two of the young were flycatching high in the trees where the female, calling *wert* infrequently, sometimes joined them, causing their *tseep* notes to grow more insistent though she did not feed them.

Although the male remained in the territory at least until August 3, when I concluded my study, never after July 18 did I see him feed the fledglings; but on the evening of the 20th and again perhaps on the 22nd he may have participated in this activity because the feedings were so frequent—often at intervals of a few seconds—it seemed impossible that the female alone could have supplied the needs of all three young. On July 24, just at noon, the male, which had been singing his *ka-zeep* nearby, flew to the branch where the three fledglings were perched side-by-side. Yet though he alighted next to them he made no attempt to feed and quickly flew away. He sang his *ka-zeep* song each day—sometimes frequently, sometimes fitfully—through August 1, but I did not hear it on the final two evenings I visited the woods.

After a five-day absence I returned to the woods on the morning of August 8, to find just one Acadian Flycatcher, its plumage notably fresh and trim.

Since migration had not yet begun, I had to assume that this bird was one of the five that had spent the summer there.

Use of the *Pee-tul* Song by the Male

Some additional comment must be made on the varied uses of the *pee-tul* song by the male because it was obvious that these sweet, rather liquid, warbled or fluted notes were not sung solely while in the presence of the female. Apparently any state of high excitement caused the male to utter them, for he used them to express alarm on the tenth day of nest life when he perched only a few yards away as I stood peering in at the young, and again two days later when I entered the woods and took up my post of observation at the top of the slope. On July 9, at 8:45 p.m., both birds participated in a unique performance lasting perhaps 30 seconds in which one fluttered after the other just a few feet above the ground and about 25 feet from the nest site, the male all the while calling *pee-tul* but in a more subdued, almost muted, manner than was customary with him. Also, on the evening of July 15, the last day of nest life, the male on three occasions within 15 minutes uttered the *pee-tul* phrase in normal tones, once while flying in a small circle at a height of about 30 feet above the path at the base of the slope just below the nest site.

The male seemed to become more jealous of his territorial rights after the young had left the nest, and on the morning of July 17, as well as on several days thereafter, he engaged an Eastern Wood Pewee, and once, too, I believe, a Red-eyed Vireo in mad, dashing pursuit in and out among the treetops over a very limited area. During these chases and sometimes promptly at their conclusion the male often uttered his *pee-tul* song, rather louder, however, and with a more high-pitched quality than when he sang it to his mate at the nest.

Summary

A partially-completed nest of an Acadian Flycatcher was discovered in a small second-growth woodland in Cleveland Heights, Ohio, on June 12, 1954, the female Flycatcher continuing to work on it that day and the following day.

The first egg was laid between the morning of June 16 and the evening of June 17, and a second and a third egg on the two succeeding days. Incubation, in which the male seemingly played no part, continued for 14 days, through July 2. Two of the eggs had hatched before 1:45 p.m., July 3, while the third hatched during the next three hours.

The young remained in the nest for 13 days, through July 15, with the female apparently doing all of the brooding. The male did, however, take part in the feeding of the young both in the nest and on at least the first three days after their departure from the nest.

All three young, which left the nest on the morning of July 16, remained

together through August 2, the parent birds also remaining in the woodland. On August 3, when observation was discontinued, only two of the young and the adults could be found.

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14174 Superior Road, Cleveland Heights 18, Ohio, May 24, 1957

FOOD INTAKE AND PELLET FORMATION OF A HORNED OWL

BY WALTER E. HOWARD

An adult Horned Owl (*Bubo virginianus*) was captured at the San Joaquin Experimental Range, O'Neals, Madera County, California, on April 28, 1948. The owl was kept in a small cage and fed weighed amounts of food from April 28 until August 26, 1948, when it was released. The owl weighed 1,207 grams on the date of capture, and when released it weighed 1,220 grams. The number and frequency of pellets regurgitated by the owl were recorded for the four-month period. Food consisted of a variety of animals, but ground squirrels (*Citellus beecheyi*) and pocket gophers (*Thomomys bottae*) were the main items. The owl appeared to prefer small forms of prey to squirrels or cottontails (*Sylvilagus auduboni*). Unless indicated that it was alive, all prey items fed the owl were dead at the time they were put in the cage.

Feeding experiments (Table 1) revealed that when a Horned Owl is feeding on small prey, such as birds, mice or pocket gophers, the pellets are usually large (often three to four inches long) and frequent in appearance. However, when an owl is feeding on large species of prey, such as ground squirrels and cottontails, the pellets are generally much smaller (often an inch or less) and are formed less frequently. Apparently this is because with larger prey, where much of the meat is torn free of bones, a greater percentage of the material actually swallowed by the owl is digestible than is the case when they are swallowing rodents or birds intact. This is an important matter to take into consideration when evaluating food habits of owls from pellets collected in the field.

During 75 days of the study, when all food items were weighed, approximately 8,706 grams were consumed by the owl, for an average daily ration of 116 grams. This daily ration is equal to about 10 per cent of the owl's body weight. Fifty-five pellets were formed during this period, for an average interval of 1.36 days per pellet. This means that an average of about 158 grams was consumed for the formation of each pellet. The pellets were not weighed until eight years after their collection, when they were thoroughly air dry. The pellets then weighed from 0.4 to 18.0 grams, averaging 5.36 grams per pellet.

Another bit of information obtained by this study was that the Horned Owl was not susceptable to secondary poisoning when it fed upon rodents poisoned with Compound 1080. This is in agreement with findings of the U. S. Fish and Wildlife Service, which has shown that birds are far more tolerant to 1080 than most mammals. In an interval of 51 days the owl was

fed 14 ground squirrels and one pocket gopher that had first been poisoned in cages with 1080 rodent bait. Seven of the poisoned squirrels were fed during a period of 19 days. The owl seldom ate intestines of ground squirrels.

TABLE 1

ITEMS FED A CAPTIVE HORNED OWL AND FREQUENCY OF PELLET FORMATION

1948 Date	Hour	Items Fed[1]	Weight in Grams	Amount Eaten Since Prev. Examination	Wt. in Gms.	No. of Pell.	Wt. in Gms.[2]
Apr. 28	4:30 p.m.	Mourning Dove[3]	107	–	–	–	–
Apr. 29	8:45 a.m.	Pocket Gopher	107	Dove, except feet and tail	95	0	0
	4:30 p.m.	Ground Squirrel and Pocket Gopher (1)	320	0	0	0	0
Apr. 30	8:30 a.m.	0	0	Heart and lung of squirrel and all of gopher (1)	123	2	11.8
	5:10 p.m.	5 Pocket Gophers (2)	387	0	0	0	0
May 1	10:00 a.m.	0	0	All but head and tail of squirrel (1). One gopher (2)	202	1	4.6
	6:00 p.m.	Live Brewer Blackbird[4] (3)	56	0	0	1	10.0
May 2	7:10 p.m.	0	0	4 gophers (2)	310	1	15.0
May 3	7:30 a.m.	0	0	Rest of squirrel (1)	72	0	0
	5:00 p.m.	Live Mourning Dove	139	0	0	1	12.4
	8:00 p.m.	Pocket Gopher and Gopher Snake[5]	481	0	0	0	0
	12:00 p.m.	0	0	Dove	139	0	0
May 4	8:00 a.m.	0	0	Blackbird (3) and gopher; snake removed	134	0	0
	12:05 p.m.	2 Pocket Gophers	198	0	0	0	0
	4:35 p.m.	0	0	Head of 1 gopher	25	1	13.7
	5:15 p.m.	Pocket Gopher and *Ground Squirrel (4)[6]	585	0	0	0	0
May 5–6	Not attended						
May 7	9:00 a.m.	0	0	3 gophers and all but head, tail and feet of squirrel (4)	683	2	25.0
	4:30 p.m.	Pocket Gopher	88	0	0	1	2.5

[1]Numbers in parentheses are to provide identity between food items offered and amount subsequently known or estimated to have been eaten.
[2]Pellets were air-dried for eight years before being weighed.
[3]***Zenaidura macroura***
[4]***Euphagus cyanocephalus***
[5]***Pituophis catenifer***
[6]Food items preceded by an asterisk were poisoned with Compound 1080 before being fed to the owl.

1948 Date	Hour	Items Fed[1]	Weight In Grams	Amount Eaten Since Prev. Examination	Wt. in Gms.	No. of Pell.	Wt. in Gms.[2]
May 8	9:55 a.m.	0	0	Gopher	88	0	0
	11:30 a.m.	Pocket Gopher	72	0	0	0	0
	4:45 p.m.	0	0	0	0	0	0
	5:15 p.m.	Pocket Gopher	70	0	0	1	10.7
	6:05 p.m.	0	0	Gopher	70	0	0
May 9	8:45 a.m.	Pocket Gopher (5)	77	Gopher	72	0	0
	12:45 p.m.	Brown Towhee[7] (6)	61	Gopher head (5)	20	1	9.9
	6:20 p.m.	Pocket Gopher	68	Part of gopher (5)	20	0	0
May 10	9:00 a.m.	0	0	Gopher and rest of gopher (5)	101	0	0
	1:45 p.m.	2 Pocket Gophers	143	0	0	0	0
	5:20 p.m.	Pocket Gopher	68	Towhee (6) and 2 gophers	204	1	8.9
May 11–12	Not attended						
May 13	2:00 p.m.	0	0	Gopher; remains of squirrel (4) removed	68	3	12.5
	5:20 p.m.	Ground Squirrel (7)	792	0	0	0	0
May 14	11:00 a.m.	0	0	Part of squirrel (7)	100	0	0
May 15	10:10 a.m.	Rattlesnake[8] (8)	888	More of squirrel (7)	100	0	0
May 16	12:35 p.m.	0	0	More of squirrel (7)	100	1	2.6
	5:45 p.m.	Refrigerated Pocket Gopher (9)	92	0	0	0	0
May 17	4:30 p.m.	0	0	0	0	0	0
May 18	8:30 a.m.	0	0	Remainder of squirrel (7), snake (8), and gopher (9) removed	0	0	0
	2:15 p.m.	*Ground Squirrel (10)	590	0	0	0	0
May 19	5:55 p.m.	0	0	Much of squirrel (10)	300	1	3.1
May 20	9:00 a.m.	0	0	More of squirrel (10)	100	0	0
May 21	8:30 a.m.	0	0	All but head, tail and some skin of squirrel (10)	100	0	0
	5:25 p.m.	*Ground Squirrel (11)	486	0	0	1	1.5
May 22	8:30 a.m.	0	0	Part of squirrel (11)	100	1	3.8
May 23	7:15 p.m.	0	0	Rest of squirrel (10) and most of squirrel (11)	340	2	4.5
May 24	4:00 p.m.	0	0	?	?	0	0

[1] Pipilo fuscus
[8] Crotalus viridis

1948 Date	Hour	Items Fed[1]	Weight in Grams	Amount Eaten Since Prev. Examination	Wt. in Gms.	No. of Pell.	Wt. in Gms.[2]
May 25	8:20 a.m.	*Ground Squirrel (12)	312	Head and tail of squirrel (11) removed	100	0	0
May 26	9:30 a.m.	0	0	All but hind quarters and part of head of squirrel (12)	200	0	0
May 27	4:00 p.m.	0	0	All but part of head of squirrel (12)	75	3	8.9
May 28	9:45 a.m.	0	0	0	0	1	0.8
May 29	8:35 a.m.	*Ground Squirrel (13)	693	Part of head of squirrel (12) removed	0	0	0
	10:05 a.m.	*Pocket Gopher	53	0	0	0	0
	4:25 p.m.	0	0	Gopher	53	0	0
May 31	9:55 a.m.	0	0	Half of squirrel (13)	350	0	0
	11:00 a.m.	2 live Scrub Jays[3] (14)	170	.			
June 1	5:45 p.m.	Live Scrub Jay (15)	71	Head of 1 jay (14) and more of squirrel (13)	110	1	5.3
June 2	10:00 a.m.	0	0	Most of 2 jays (14)	150	1	2.7
	7:30 p.m.	0	0	?	?	1	2.2
June 3	11:15 a.m.	0	0	Part of all 3 jays (14, 15)	50	1	1.7
	8:45 p.m.	4 Pocket Gophers (16)	238	0	0	0	0
June 4	8:45 a.m.	0	0	3 gophers (16); remainder of squirrel (13) and jays (14, 15) removed	180	0	0
June 5	8:00 a.m.	*Ground Squirrel (17)	303	Gopher (16)	58	1	8.9
June 6	12:30 p.m.	0	0	0	0	0	0
	5:30 p.m.	0	0	All but head and rear end of squirrel (17)	200	1	1.1
June 7	Not attended						
June 8	8:20 a.m.	0	0	Most of squirrel (17)	50	0	0
	5:05 p.m.	Live Ground Squirrel (18)	220	0	0	0	0
June 9	1:35 p.m.	0	0	All but rear end of squirrel (18); remains of squirrel (17) removed	175	0	0
	4:20 p.m.	Live Ground Squirrel (19)	750?	0	0	0	0

[1]*Aphelocoma coerulescens*

1948 Date	Hour	Items Fed[1]	Weight in Grams	Amount Eaten Since Prev. Examination	Wt. in Gms.	No. of Pell.	Wt. in Gms.[2]
June 10	11:00 a.m.	0	0	Squirrel (19) alive	0	2	7.4
	5:05 p.m.	*Ground Squirrel (20)	714	Ditto	0	0	0
June 11	3:30 p.m.	*Ground Squnrrel (21)	?	?	?	1	3.2
June 12–28		Fed 4 (all*) Ground Squirrels in author's absence	?	?	?	4?	?
June 28	3:45 p.m.	*Ground Squirrel (22)	292	Cleaned cage	?	—	—
June 29	9:00 a.m.	0	0	Part of squirrel (22)	100	1	0.9
	5:10 p.m.	0	0	0	0	1	2.3
June 30–July 1	Not attended						
July 2	10:35 a.m.	Hamster[10] and Live Scrub Jay	130	Removed rest of squirrel (22)	100	0	0
	5:30 p.m.	0	0	Jay escaped?	0	0	0
July 3	9:15 a.m.	0	0	Hamster	44	0	0
July 4	10:30 a.m.	Pocket Gopher	70	0	0	0	0
	11:10 a.m.	0	0	Head of gopher	10	0	0
July 5	9:15 a.m.	0	0	Rest of gopher	60	1	5.4
	9:30 a.m.	*Ground Squirrel	754	0	0	0	0
July 6	9:00 a.m.	0	0	Part of squirrel	200	0	0
July 7	8:00 a.m.	0	0	?	?	0	0
July 8–30		Fed Ground Squirrels and Cottontails in author's absence	?	?	?	?	?
July 31	12:15 p.m.	Hamster	50	Cleaned cage	—	—	—
	8:00 p.m.	0		Hamster	50	1	3.8
Aug. 1	9:55 a.m.	Ground Squirrel (23)	541	0	0	1	9.5
Aug. 2	10:00 a.m.	Mourning Dove	98	Much of squirrel (23)	300	1	5.8
Aug. 3	Not attended						
Aug. 4	2:45 p.m.	Pocket Mouse[11]	10	Dove; squirrel (23)?	98	1	1.9
Aug. 5	5:00 p.m.	3 Kangaroo Rats[12]	110	Pocket Mouse	10	0	0
Aug. 6	Not attended						
Aug. 7	7:45 a.m.	Ground Squirrel (24)	406	3 Kangaroo Rats	110	1	6.5
	5:30 p.m.	0	0	Part of squirrel (24)	100	1	3.3
Aug. 8	8:45 a.m.	0	0	Most of squirrel (24)	250	0	0
	11:40 a.m.	Brown Towhee (25)	49	0	0	0	0
	2:45 p.m.	0	0	0	0	1	6.0
Aug. 9	8:00 a.m.	Brown Towhee (26) and Ground Squirrel (27)	352	Brown Towhee (25); remains of squirrel (24) removed	49	1	3.4
	4:45 p.m.	Brown Towhee (28)	45	Brown Towhee (26)	37	0	0
	8:00 p.m.	Brown Towhee (29)	36	0	0	0	0

[10] **Mesocricetus auratus**
[11] **Perognathus inornatus**
[12] **Dipodomys heermanni**

1948 Date	Hour	Items Fed[1]	Weight in Grams	Amount Eaten Since Prev. Examination	Wt. in Gms.	No. of Pell.	Wt. in Gms.[2]
Aug. 10	7:30 a.m.	0	0	Both towhees (28, 29) and part of squirrel (27)	156	1	3.4
Aug. 11	8:00 a.m.	0	0	Some of squirrel (24)	100	1	2.6
Aug. 12	9:15 a.m.	0	0	Removed rest of squirrel (27)	0	0	0
	5:20 p.m.	Ground Squirrel (30)	437	0	0	0	0
Aug. 13	7:50 a.m.	0	0	Part of squirrel (30)	150	1	0.7
	4:00 p.m.	Ground Squirrel (31)	336	Most of squirrel (30)	200	1	7.2
Aug. 14	Not attended						
Aug. 15	7:45 p.m.	0	0	All but heads of squirrels (30, 31)	350	2	8.1
Aug. 16	11:15 a.m.	Kangaroo Rat	53	0	0	2	11.2
Aug. 17	8:00 a.m.	Ground Squirrel (32)	400?	Kangaroo Rat	53	1	4.3
	5:00 p.m.	0	0	Back of neck of squirrel (32)	20	0	0
Aug. 18	8:30 a.m.	0	0	Much of squirrel (32)	175	0	0
	5:10 p.m.	0	0	0	0	1	3.7
Aug. 19	9:15 a.m.	0	0	More of squirrel (32)	100	1	0.4
Aug. 20	8:30 a.m.	0	0	More of squirrel (32)	75	0	0
Aug. 21	8:15 a.m.	0	0	0	0	0	0
	7:55 p.m.	Brown Towhee	51	0	0	0	0
Aug. 22	11:00 a.m.	Brown Towhee (33) and Ground Squirrel (34)	633	Brown Towhee; rest of squirrel (32) removed	51	0	0
Aug. 23	8:15 a.m.	0	0	Brown Towhee (33) and part of squirrel (34)	153	0	0
	1:15 p.m.	0	0	0	0	1	10.4
Aug. 24	8:30 a.m.	0	0	More of squirrel (34)	200	0	0
	5:10 p.m.	0	0	0	0	1	2.5
Aug. 25	10:30 a.m.	Pallid Bat[13] and Rattlesnake	179	0	0	0	0
Aug. 26	8:15 a.m.	0	0	0	0	0	0
	10:30 a.m.	Photographed and released	0	0	0	0	0

[13] **Antrozous pallidus**

FIELD STATION ADMINISTRATION, UNIVERSITY OF CALIFORNIA, DAVIS, CALIFORNIA, SEPTEMBER 14, 1956

ACOUSTIC EVIDENCE OF RELATIONSHIP IN NORTH AMERICAN CROWS

BY L. IRBY DAVIS

THERE has been much difference of opinion as to how the crows of North America should be classified. The Northwestern Crow (*Corvus caurinus*) was originally described as a distinct species, but later (1931) listed as a race of the Common Crow (*Corvus brachyrhynchos*) by the American Ornithologists' Union Committee. After retaining that classification for many years, the latest "Checklist" (1957) again elevates the Northwestern Crow to full specific rank. (In the meantime it had been listed as a race of the Fish Crow, *C. ossifragus*, by Hellmayr, 1934.) In a similar manner there has been considerable discussion as to whether or not isolated populations, such as the Fish Crow of the eastern United States and the Mexican crows should be considered conspecific. (*C. imparatus* was listed as a race of *C. ossifragus* by Blake in 1953). When one reads the published data on various forms in museum collections, it becomes apparent why there is so much difficulty in trying to set up a classification based upon such morphological findings as are revealed by the skins. Using the data published by Ridgway (1904:266–275), one will find that (with the exception of the tarsus) the measurements given for the Common Crow overlap completely those of the other two species with which it comes in contact. The longest tarsus reported for a male Fish Crow is 47 mm., and the longest for a male Northwestern Crow is 53 mm., whereas the shortest tarsus given for a male of the western race of the Common Crow (*C. b. hesperis*) is 54.3 mm. However, when it is seen that the longest tarsus of *hesperis* is 58.5 mm. and the shortest for a male of *C. b. brachyrhynchos* is 60.0 mm., it becomes evident that there may be no overlapping in this character in the races within a species; hence, the specific taxonomic importance of that point becomes doubtful. Since there is so much variation in the measurements of different individuals, it was thought that perhaps ratios might give a better picture of certain characters. With this in mind, measurements were obtained from skins of random samples representing various populations, and the ratios of wing-length to tail-length calculated. The results are shown in Table 1. Disregarding the sexes and races the total variation in the Common Crow was from 1.63 to 1.82, the Northwestern Crow from 1.65 to 1.85, and the Fish Crow from 1.69 to 1.83. Hence it is seen that this ratio is essentially the same in all these species.

The western race of the Common Crow is more glossy on the back than the Northwestern Crow with which it comes in contact. Also, the plumage of the Fish Crow is more glossy than that of the races of the Common Crow which it meets. In some cases this difference is so slight as to be hardly noticed;

hence, it would not likely in itself serve as an effective barrier to interbreeding of the species.

One trait which is different in these species is the voice. Field students have repeatedly pointed out these differences in areas where the Common Crow comes in contact with the Northwestern Crow, and with the Fish Crow. Brooks (1942) was quite emphatic in pointing out that the distinctive voice had greater significance than measurements of skins in the Northwestern Crow. Studies have produced information tending to show that in genera, such as the forest thrushes, *Catharus*, in which the species all appear rather similar, the voice is of prime importance in species recognition (Dilger, 1956). Since it is quite possible that in North American crows, difference in voice is the main barrier to interbreeding, it was thought that a study of the calls might throw light on the taxonomic problems. Accordingly, the usual calls of the various species were analysed and the results reported herein.

Acknowledgments

I would like to express my appreciation to the members of the staff of the Laboratory of Ornithology at Cornell University for their valuable assistance and advice. I am especially indebted to Dr. Paul Kellogg for making spectrograms of the call of the Northwestern Crow in my absence, and to David G. Allen for making the photographs of the audio-spectrograms.

Materials and Methods

All the tape recordings of the voices of crows in the Library of Natural Sounds at the Laboratory of Ornithology at Cornell University were reviewed and what seemed to be representative examples of the typical or usual call of each species were selected for analysis. Audio-spectrograms were made of these calls and photographs then made of the audio-spectrograms. The use of the audio-spectrograph has been explained in detail by Potter (1947), and its use in the analyses of bird song discussed by Kellogg and Stein (1953). In the present study it was found desirable to use two different tape speeds for feeding the voice recordings into the audio-spectrograph machine in order to demonstrate different features of the calls. The "fast" tape speed used was double that at which the original recording was made and the "slow" speed was one half that at which the original recording was made.

Discussion

Common Crow. *Corvus brachyrhynchos.*—By far the widest ranging of any North American species, this crow is found over most of the United States and southern Canada. It comes in contact with the Northwestern Crow in the northwestern part of its range (coastal British Columbia), and with the Fish Crow in the southeastern part of its range. The usual call may be described as a short "caah" with a quick rise in inflection at the beginning and almost as quick a fall at the end. There is a slight difference in pitch between the sexes but otherwise the sound is the same. (Since it has been observed in the field

TABLE 1

RATIO OF WING LENGTH TO TAIL LENGTH IN SELECTED POPULATIONS OF NORTH AMERICAN CROWS[1]

Species or race	Range of ratios in males		Range of ratio in females
Corvus b. brachyrhynchos	1.67 to 1.77	:	1.65 to 1.82
Corvus b. pascuus	1.69 – 1.82	:	1.76 – 1.79
Corvus b. hesperis	1.71 – 1.79	:	1.63 – 1.79
Corvus caurinus	1.65 – 1.85	:	1.70 – 1.85
Corvus ossifragus	1.69 – 1.82	:	1.71 – 1.83

[1] Measurements from Ridgway, 1902.

that the larger of a pair of crows has the lower-pitched voice, it is assumed in this discussion that the lower-pitched member of a pair of birds is the male.)

Figures (1) through (6) in Plate 1, represent a series of calls of a pair of Common Crows. (The tape was not edited or altered and the spacing is just as it was arranged by the birds.) Here, as in all other plates, the intervals between the graduations on the horizontal scale represent 1/10 second, and the vertical scale shows the frequency in cycles per second. Calls (1), (2), and (5) were made by the presumed female and (3), (4), and (6) by the male. One call of the male and one of the female, (4) and (5), were selected for detailed study. The calls are made up of a series of harmonic bands which are almost exactly duplicated each time the call is repeated. In each case the fundamental is weak and appears as a light smudge in the area between 500 and 1000 cycles. The second harmonic in each case is strongly resonated, the third is considerably weaker than the second, and the fourth is again quite weak. The steepness of the rise and fall in inflection of each succeeding harmonic appears to be exaggerated because of the linear frequency scale used in the spectrograms. In order to facilitate the discussion and to make comparison of different calls easier, the use of two terms should be defined.

Since, in these short calls, the loudest part is thought to be that which affects the ear for the most part, the center of the darkest part of each harmonic band will be called the *effective frequency* of that harmonic. And, since the loudest or most strongly resonated harmonic is the one which most affects the ear, the effective frequency of that harmonic will be designated the *pitch* of the call. This spectrogram was made with a wide (300-cycle) filter, which, in this case, resolves the calls into distinct harmonic bands. The curvature of the harmonic bands indicates the rise and fall in inflection used by this species in its call. Hence, it is seen that the spectrogram gives a picture of the form, harmonic make-up, pitch, and duration of the calls. When a tape recording

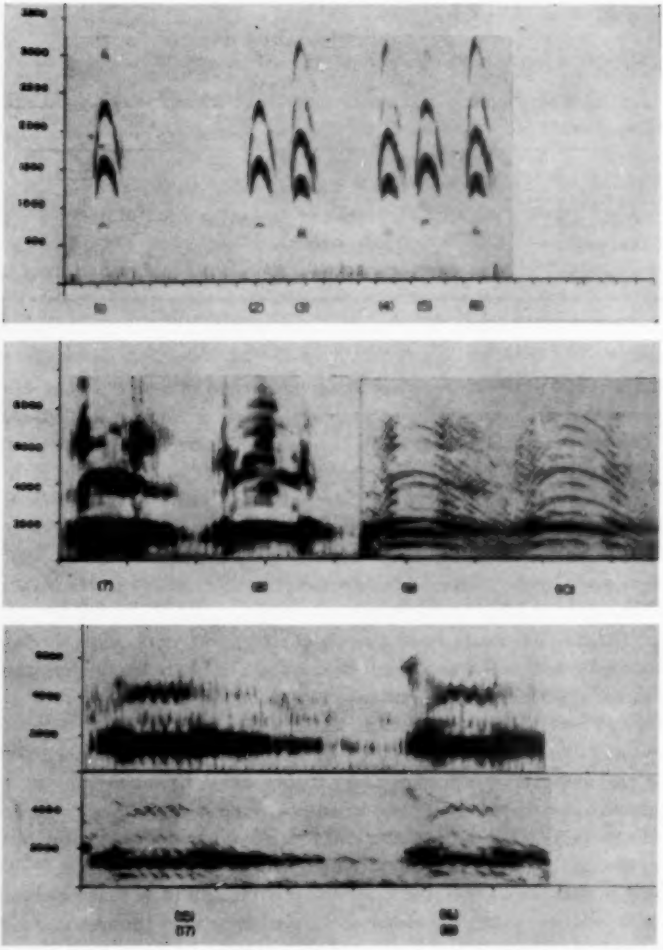

PLATE I. Sound spectrograms of the Common Crow (Figs. 1–18) See text for explanation.

is played at one half the speed at which it was made, the time taken for a call is doubled and the pitch is reduced one octave. Such methods are used to obtain different kinds of information from an audio-spectrogram. Figures (7) and (8) were made from the same calls as (4) and (5) but the tape was run at only

one fourth the speed previously used. Consequently, the distance between the 1/10 second graduations on the horizontal scale becomes four times as great, and on the vertical scale 8000 cycles are now crowded into the space formerly occupied by 2000 cycles. Since the harmonic bands are pushed down closer together, many more of them fall within the range of the spectrogram; also, since these bands are now greatly stretched out, they are also flattened. The harmonic bands are now so close together that the wide (300-cycle) filter "sees" them merely as dark, blurred bars. Calls (9) and (10) also are the same as (4) and (5) and this spectrogram was made at the same tape speed as used for (7) and (8) but a narrow (45-cycle) filter was used. The narrow filter is able to resolve the calls into distinct harmonic bands, providing a more complete picture of the whole call. The dark shadow representing the main area of resonance passes squarely over the second harmonic in both the male (9) and female (10) spectrograms. In the case of the female call the third harmonic is largely outside the area of resonance, but the extreme ends of the band are of low enough frequency to fall just within this area. Some of the upper harmonics, such as the sixth, are stressed slightly more than the others and this no doubt adds to the quality of the voice. The fundamental is now more clearly defined and is found to be of an effective frequency of 638 cycles per second in the male and 756 cycles in the female (as nearly exactly as could be measured with a mm. scale). The pitch of the male call is 1276 cycles per second and the female is 1504 cycles per second.

As well as the clear calls discussed above, the Common Crow frequently gives one of a more burry or vibratory quality. Figures (15) and (16) represent two such calls (presumably both given by the same bird). Figures (17) and (18) represent the same two calls but were made by using the narrow filter. All were made at the same "slow" speed used in (7), (8), (9), and (10); hence, the scales are the same. From the wavy form of the harmonic bands it is seen that the peculiar quality of these calls is caused by a "vibrato" in the voice. Modulating the voice with this vibrato changes the general appearence of the picture, but a comparison of (18) with (10) will show that there are no differences of a fundamental nature. Again the second harmonic is dominant, the third shows little resonance except at the extreme ends, the fundamental is quite weak, and the sixth harmonic although weak is relatively stronger than the fourth and fifth (the fifth failed to show at all in this print). (The small patch of dark marks at the upper left of Fig. 16 is not part of the call, but is "interference" by another bird.) The fact that the fundamental is quite weak and that the sixth harmonic is resonated more strongly than the seventh suggests that this call was given by a female (see Fig. 10). The end of the first call, (15), (17), is more drawled out than any of the others and this makes the call over 3/10 of a second long.

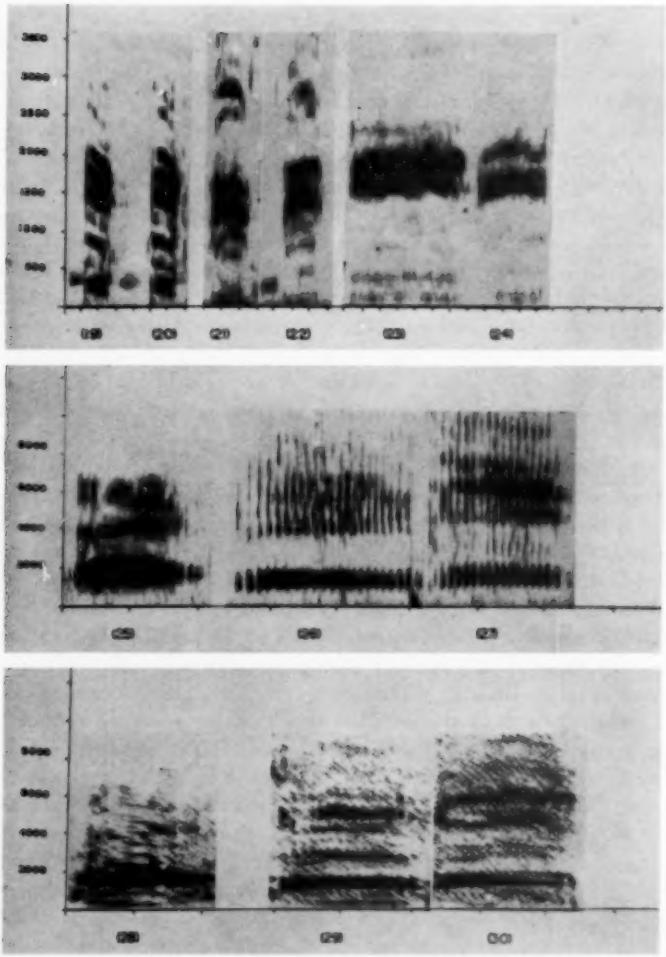

PLATE 2. Sound spectrograms of the Fish Crow (Figs. 19, 20, 25, 28) and Tamaulipas Crow (Figs. 21–24, 26, 27, 29, 30). See text for explanation.

Fish Crow. *Corvus ossifragus.*—This species ranges along the Atlantic coast of the United States and the Gulf coast to extreme eastern Texas. It is in contact with the Common Crow throughout its range but does not meet any other species of *Corvus*. Field students have reported the call of the Fish Crow as

being shorter than that of the Common Crow and more of a nasal quality. I do not know how "nasal quality" would show up on an audio-spectrogram, but the duration of the call may be readily studied. Two calls of the Fish Crow are represented by Figs. (19) and (20). This spectrogram was made to the same scale as that which showed calls (1) through (6) of the Common Crow, and it is seen that they are indeed somewhat shorter than the calls of the Common Crow. However, the most noticeable thing about the spectrograms is the striking difference in form. Possibly that is what makes the difference in quality of the sound. As in the case of the Common Crow in (4) and (5), there is a resonant area from about 1400 to about 2000 cycles per second, and here again the lowest harmonic in the area of resonance seems to be somewhat more heavily emphasized. However, all other points are quite different. The fundamental is of a much lower frequency (below 500 cycles); hence the harmonics are much closer together. In this case the harmonic bands are not strongly bowed up and down but are relatively straight with a slight tilting down, indicating that the frequency falls slightly during the call. The fundamental appears to be considerably stronger. By slowing the tape down to one fourth the previous speed a spectrogram as shown in (25) was produced (compare with Common Crow, Figs. 7 and 8). Although the general areas of resonance are similar, the Fish Crow spectrogram presents a much "coarser" picture due to the plainly visible vertical lines which represent the actual vibration rate of the voice. Call (28) is the same as (25) but the spectrogram was made with the narrow filter. In this case the narrow filter fails to resolve the harmonics into complete bands (compare with Common Crow, Figs. 9 and 10). When the harmonics are spread further apart by speeding up the tape, the narrow filter is able to resolve them into distinct bands. This same call was used to make (35), but the fast speed of (20) was used as well as the narrow filter. From (35) it was determined that the pitch was 1390 cycles per second (this is for the fifth harmonic which seems to be almost exactly equal to the sixth in this print but in some other prints seemed to be a bit stronger).

Tamaulipas Crow, *Corvus imparatus*.—Although averaging half an inch smaller, the shape and the overlapping of the measurements of the skins has led many taxonomists to consider this bird a race of the Fish Crow even though the two populations have been isolated for a very long time. Measurements made on 10 males from Tamaulipas in the U.S. National Museum give wing-to-tail ratios varying from 1.63 to 1.72, and two males from the American Museum of Natural History fell within this range. (Seven females from the U.S. National Museum had wing-to-tail ratios varying from 1.65 to 1.68.) Hence, it is seen that in this population the ratios of these measurements fall completely within the range for the various populations cited in the introduc-

tion above. However, in spite of all these similarities, these birds differ from the Fish Crow in the field in three easily apparent repsects: first, the habits and habitat are different; second, the plumage is a more lustrous violet-black; third, the voice is very different. The preferred habitat is semi-desert brushland (the towns, villages, farms, and ranch yards in the region are frequented as well as the brushy areas themselves); however, a few birds occasionally wander into open places in more humid woods at the limit of the usual habitat. Tall forests, true deserts, mountains, and the sea beach all are avoided. The species ranges from China, Nuevo Leon, eastward to the lower tip of the Rio Grande Delta and southward (via Linares, Nuevo Leon) to the area about 15 miles south of Valles, San Luis Potosí, and to the northern border of Veracruz in the vicinity of Tampico, Tamaulipas. This is a strip roughly 100 miles wide and 250 miles long mostly in the state of Tamaulipas. Most of the birds are found between 100 and 1000 feet elevation but a few occur near sea level and up to about 1400 feet.

The voice of this species is so different from those previously considered that it is hard at first for an observer to believe that the sound is made by a crow. It is burry, low-pitched, and relatively low in volume, and sounds something like a frog croaking softly or someone plucking on a "Jew's-harp." Spectrograms of two typical calls are shown in (21) and (22). These represent male and female, respectively, and were recorded in a brushy pasture east of El Mante, Tamaulipas. The tape was played at the same "fast" speed as was used for Fish Crow call (20) and hence all have the same scale. These spectrograms present a coarser picture than any previous ones; no harmonic bands are resolved; and only blurred resonant areas are shown, with the fundamental more or less lost in the "noise" of the base line. Figures (23) and (24) represent longer calls that are less often heard; these were recorded about 15 miles southeast of El Mante. From the pitch it is presumed that they were made by females. Aside from the greater length, these spectrograms present the same form and structure as those of the shorter calls. Figures (26) and (27) represent the same calls as (21) and (22) but were made with the tape moving only one-fourth as fast, which gives them the same scale as Fish Crow call (25) and makes them directly comparable. It is seen that the calls of the Tamaulipas Crow give a much coarser picture than that of the Fish Crow; that the resonant areas are different; and that even the shorter calls are longer than that of the Fish Crow. Figures (29) and (30) represent the same two calls analyzed with the narrow filter. Whereas in the Fish Crow (28) there was some slight resolution of harmonic bands, there is none at all in (29) and (30), but only dark resonant bars. Even with the fine filter there is still evidence of the vertical sound pulse lines. This again indicates that it is necessary to use a much faster speed in order to show the harmonics. By going back to the fastest

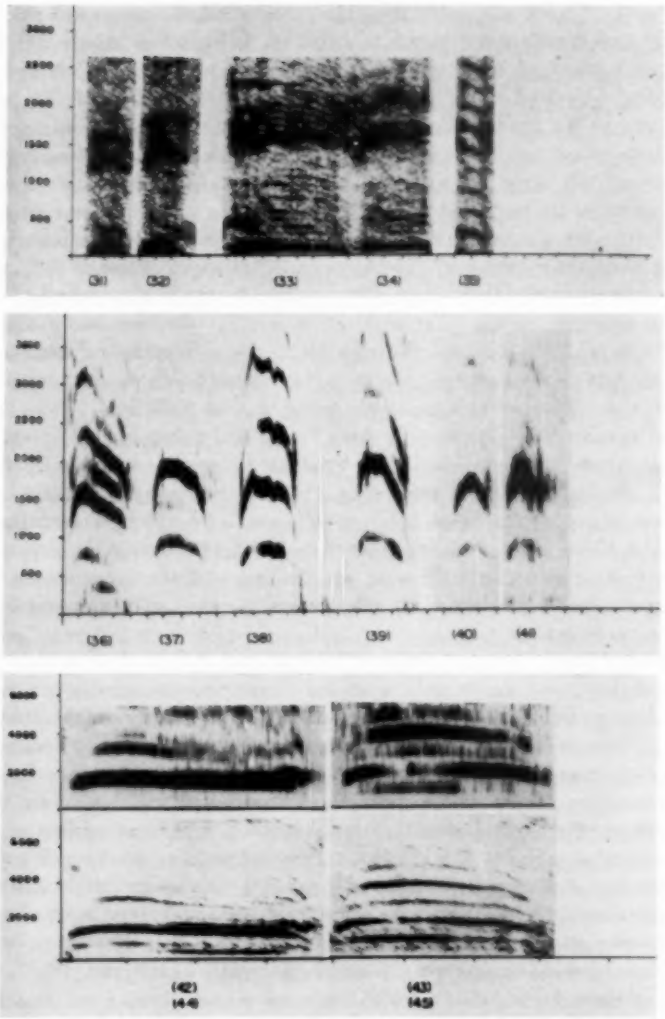

PLATE 3. Sound spectrograms of the Tamaulipas Crow (Figs. 31–34), Fish Crow (Fig. 35) and Sinaloa Crow (Figs. 36–45). See text for explanation.

speed used in this study and making spectrograms with the narrow filter, figures (31) and (32) were made with the same calls as used in (21) and (22),

(26) and (27), and (29) and (30). The fundamental now shows well although it is of such low frequency that it is almost on the base line. Above this there is a long series of harmonic bands that are quite close together and not completely resolved at any point even at the high speed used. By using multiples of the fundamental frequency, however, it is possible to calculate which harmonic would fall in the densest part of the resonance area between 1000 and 1500 cycles per second. The fundamental frequency is 82.3 cycles per second in the male and 90.0 in the female; the pitch of the male call is 1235 cycles per second, and the female, 1350 cycles, with the fifteenth harmonic being dominant in each case. The longer calls, shown in (33) and (34), since they show more horizontal area, give a picture in which it is easier to follow the incompletely resolved harmonics. Figure (33) discloses that the broad general area of resonance just above 1500 cycles is really composed of a number of very narrow resonant bars which do not exactly follow the contour of the harmonics. This causes what appear to be vertical fault lines. These "fault lines" appear to be caused by a given harmonic passing out of the area of resonance and its place being taken by another harmonic immediately thereafter. The harmonic band when outside the narrow resonant bar shows very weakly or not at all. These spectrograms are to be compared with that of the Fish Crow (35). It is seen that there is a tremendous difference in the form and structure, as well as in the frequency of the fundamental. The extremely low fundamental of this species is quite unique among North American crows.

Sinaloa Crow. Amadon (1950:497) cautioned against the arbitrary conclusion that crows with widely separated ranges were necessarily conspecific just because their skins were rather similar. Field studies on the crows of Mexico indicate that it would be well to heed that warning. Two formidable mountain ranges separated by hundreds of miles of desert present three barriers to prevent the present crow population of Tamaulipas from spreading to the west coast. There are, however, crows along the Pacific coast of Mexico with the center of population in Sinaloa. They range from southern Sonora to Colima in a strip roughly 50 miles wide and 500 miles long. The skins of these Pacific coastal birds look just like those from Tamaulipas, and gross measurements vary so little from those of Tamaulipan birds that all authors (as far as I have been able to discover), from Lawrence (1874) to Blake (1953), mentioning these birds, refer them to the same monotypic species. Since the present physiographic barriers evidently have been effective for a very long time, there can not have been any interbreeding in recent geological time, and, consequently, the two populations must have had either a common ancestor in the dim past or they must have become similar in appearance through convergence due to living in a similar latitude and climate. There would seem

to have been ample time for many mutations and genetic changes to have taken place, and a careful consideration of certain features does indicate both external and internal morphological differences. Even though the measurements of skins from this population discloses many characters that are almost or exactly the same as those from other populations, there is one unique difference. This is the only North American crow with a distinctive wing-to-tail ratio. Wing-to-tail ratios of 10 males (Amer. Mus. Nat. Hist.; U.S. Nat. Mus.) varied from 1.53 to 1.60, and those for 11 females, 1.47 to 1.61. None of the ratios in representatives of other populations measured fell below 1.63 (Table 1). Ridgway (*op. cit.*) gave only averages of the wing and tail measurements but, if calculations are made with these, the ratios are found to be 1.64 for the males (1.82 for females) of the Tamaulipas population, and 1.59 for males (1.58 for the females) of the Sinaloa population. Although such small variations may be of interest to those who like to deal in measurements of skins, other types of differences are most noticeable in the field.

The Sinaloa Crow is found on wet sand of the sea beach when the tide is out and along river estuaries; however, it also ranges back of the coast and up into the hills to elevations of 1000 feet or more. These birds are common in coastal towns and villages and also in the semi-desert deciduous woods some distance from the coast. The attraction to a salt water habitat, however, might suggest a closer relationship to the Northwestern Crow (of the northern Pacific coast) than to the Tamaulipas Crow. The main nesting activity of this population falls the first part of June instead of the middle of April as it does with the Tamaulipas Crows. The juvenal birds call with a voice which is lower in pitch (by ear) than that of the adults, whereas the Tamaulipas juveniles call with a higher pitch (again by ear) than the adults. The call of the adult Sinaloa Crow is so startlingly different from that of the Tamaulipas Crow that a considerable difference in the morphology of the voice-making mechanism is at once suggested. The usual call is a clear "ceow." Before making any audio-spectrographic analyses, the writer estimated by ear that the highest part of the call was about the second B above middle C (varying with some individuals down about four tones) and that the latter part of the call slurred down a full tone or a bit more. The voice lacks the low burry or croaking quality of the Tamaulipan birds, and sounds much more like the voice of a Brown Jay (*Psilorhinus morio*) than that of the Tamaulipas Crow. Audio-spectrographic analyses point out these differences which are detected by the human ear. Figures (36) and (37) represent a typical call of a male and female recorded 17 miles east of San Blas, Nayarit. These spectrograms were made to the same scale as those of the Common Crow (4) and (5), the Fish Crow (19) and (20), and the Tamaulipas Crow (21) and (22), and hence are directly comparable. It will be seen that except for duration, these calls

are rather similar to those of the Common Crow, but totally different from those of the Fish Crow and the Tamaulipas Crow. Calls (38) and (39) were recorded about a mile east of Altata, Sinaloa, and calls (40) and (41) near Rosario, Sinaloa. Call (40) is shorter than the average and therefore appears still more nearly alike in form to the call of the Common Crow (5). In the case of the presumed male's spectrogram (36) the fundamental is in the area below 500 cycles, the second harmonic shows weakly, the third was too weak to print, the fourth printed heavily and is dominant in the series, not much of the fifth printed except the tail end, the sixth shows rather well, the seventh scarcely printed (only a smudge at the tail end), and finally the eighth is again a bit stronger. The peaks of the bands of the second, fourth, sixth, and eighth harmonics are visible but no peaks are shown for the third, fifth or seventh harmonics. In the higher-pitched female call (37) only the second and fourth harmonic bands printed clearly. In the male and female calls (38) and (39) only the second, fourth, sixth, and eighth harmonics printed, with the fourth again dominant in each case. The call used in Fig. (40) was made by a bird from a flock and so there was no easy way of guessing its sex; however, from a comparison of the pitch with the other calls in the series it seems probable that the bird was a male. In this case the fourth harmonic is again strongly resonated and the second and eighth show weakly. The tendency of the even-numbered harmonics to be emphasized in this series of calls seems to indicate that the resonating cavities in the voice-making mechanism of these birds are such that rather widely but evenly spaced resonance bars are produced. The call used in making Fig. (41) is thought to have been made by the same bird as made call (40) but, as is seen, the spectrogram presents a different picture. The dominant dark area is considerably wider and is blurred and somewhat distorted as though more than one harmonic band were smeared together. This represents a different type of call that is sometimes given by these birds. It sounds hoarser although it is of the same pitch and seems to be a bit distorted as though the bird was straining his voice in his excitement. The hoarsness is somewhat remindful of the call of the Common Crow in which the vibrato is used; however, it appears to be differently constructed. Spectrograms (42) and (43) represent the typical male and female calls as in (36) and (37) but were made with the tape moving only one fourth as fast; hence, we again have a spread out horizontal scale and a greatly compressed vertical scale. Consequently, these are to be compared with the Common Crow calls (7) and (8), Fish Crow calls (25), and Tamaulipas Crow calls (26) and (27). It is seen that (42) and (43) have somewhat narrower and more sharply defined resonance bars than (7) and (8). The Fish Crow call (25) is more conspicuously different, and the Tamaulipas Crow calls (26) and (27) are so radically different that there is practically no basis for comparison. When these two

calls were analyzed at the slow speed with the narrow filter, spectrograms (44) and (45) were produced. When compared with the Common Crow calls (9) and (10), it is seen that although similar in general form, the resonant bars are located differently and the harmonics emphasized are not the same. The Fish Crow call (28) shows still greater differences. And again the Tamaulipas Crow calls are so entirely different as to offer no reasonable basis for comparison. When the same call as of (36) is run at high speed and the narrow filter used to make a spectrogram, the result is Fig. (51). This makes the various harmonic bands more clearly visible and shows how the second, fourth, sixth, eighth and tenth harmonics are more strongly emphasized than are the odd-numbered ones; it also shows that the fourth harmonic is clearly dominant. The effective frequency of the fundamental is 394 cycles per second and the pitch is 1504 cycles per second. Spectrograms (52) and (53) were made from two different examples of the "distorted" type of call mentioned above. The peculiar quality of these calls appears to be due to the greater number of harmonics, and the lower frequency of the fundamental. Although the basic vibrations are slower, the bird's resonating cavities give the call the same pitch; so the general form and the pitch remain the same and only the quality is changed. The fifth and tenth harmonics are now resonated, with the tenth dominant; these correspond to the second and fourth in the smooth type of call and it will be seen that the distance between the second and fourth harmonic bands in the smooth type of call is the same as the distance between the fifth and tenth harmonic band in the "distorted" call. (Because of the high pitch these last two calls, (52) and (53), are thought to have been made by females.)

Since in pitch, quality, and form as indicated by the spectrograms, the voice of the Sinaloa Crow shows a greater difference from that of the Tamaulipas population than from any other North American crow, it could easily serve to keep the birds apart even though they occurred in the same region and there were no other differences that might prevent interbreeding. Since it would be helpful to field students working with these birds to have the taxonomy reflect the obvious differences in these populations, I propose that these Pacific coast birds be known as:

Corvus sinaloae sp. nov.

Type: From Escunapa, Sinaloa, Mexico. Male, no. 71674, American Museum of Natural History, collected November 16, 1895, by J. H. Batty.

Diagnosis: Similar to *Corvus imparatus* Peters of northeastern Mexico externally, but with ratio of wing length to tail length less than 1.63; voice of adult higher-pitched (the fundamental frequency, as shown by audio-spectrograms, higher) and of quite different quality (the resonance bars, as shown by audio-spectrograms, of different shape, location, and number).

Range: Pacific coastal slope of Mexico, from Sonora to Colima.

Northwestern Crow. *Corvus caurinus.*—After the present study was begun it was discovered that there were no recordings of the voice of the Northwestern Crow available. However some time after the work reported on above was completed, Dr. Ernest Booth of Walla Walla College reported that he had accidentally recorded some calls of a Northwestern Crow in the distant background while working on another species. He very kindly made this tape available and spectrograms from it were made for use in this paper. They appear as figures (56), (57), (58), (59), and (60). The last two are the same calls as the first two but were made with the narrow filter. These weak calls are of course almost below the noise level and can not be used to estimate the pitch in the manner used in the case of other species above; however, the form and relative position of the harmonic bands in these prints may be readily compared with those in the case of other species. If these calls are typical of the species, it may be said that in the form of the harmonic bands, the Northwestern Crow is intermediate between those of the Common Crow and the Sinaloa Crow. From this it would follow that the form of the harmonic bands is somewhat alike in all three species which are found on the Pacific slope, whereas they are quite different from the form found in the two species of crows which are confined to the Atlantic slope. By measuring the distance between the harmonic bands which printed in these spectrograms, it was estimated that the fundamental was about 260 cycles per second. From this it may be calculated that it is the fourth, fifth, sixth, and seventh harmonics that appear in the spectrogram; hence, it may be surmised that the dominant harmonic is below the seventh. Although it is not possible to determine the pitch by the method of measuring as was done in the species previously analyzed, by ear the pitch seems to be from a fifth to an octave below that of a series of calls of the Sinaloa Crow.

Because of the very low fundamental and the frog-like quality of the voice of the Tamaulipas Crow, it was thought it might be of interest to compare it with the voice of the American Raven (*Corvus corax*). Fig. (54) was made from a call of the Raven with the use of the wide filter; and the same call analyzed with the narrow filter is shown in (56). When (54) is compared with (21) it is seen that although the dark areas are shifted downward by the lower pitch of the Raven, that there is a noticeable resemblance. But when spectrogram (55) is compared with (31), which is the narrow filter picture of the call of the Tamaulipas Crow, the similarity becomes striking. Thus it is seen that the spectrograms of the call of the Tamaulipas Crow more closely resemble those of the American Raven than they do those of any other North American crow.

Calls (47), (48), (49), and (50) represent typical calls of the Fish Crow,

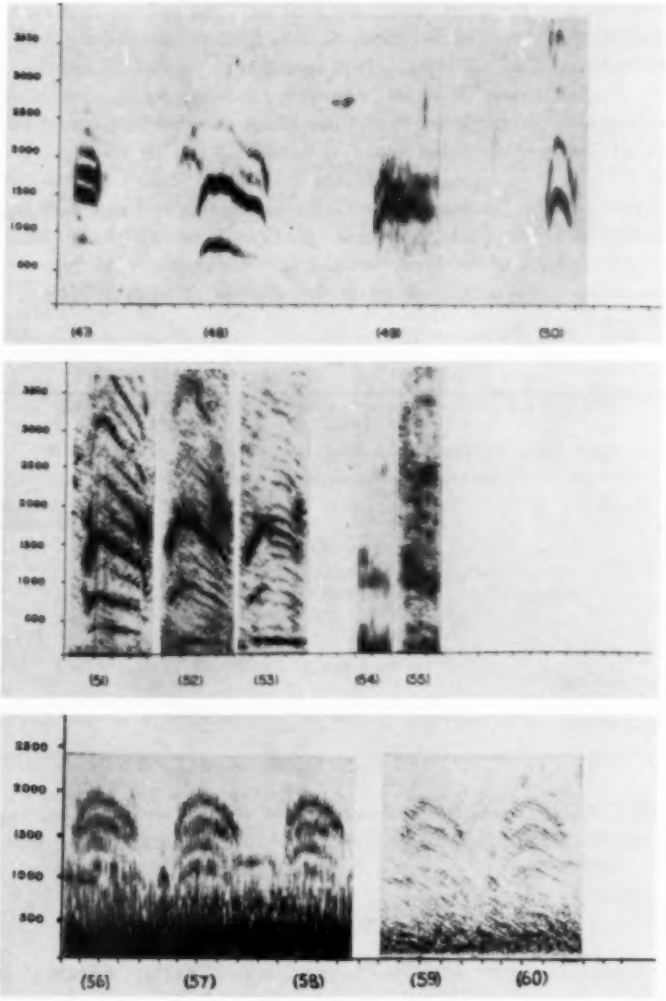

PLATE 4. Sound spectrograms of the Fish Crow (Fig. 47), Sinaloa Crow (Figs. 48, 52, 53), Tamaulipas Crow (Fig. 49), Common Crow (Fig. 50), American Raven (Fig. 54), and Northwestern Crow (Figs. 56–60).

Sinaloa Crow, Tamaulipas Crow, and Common Crow, respectively. They were all made simultaneously on a single spectrogram in order to be sure that the

printing would be the same. The mark used was light and the contrast heavy in order to best show the form and the dominant features of the calls (the weaker harmonics do not print). It is seen that the dominant resonant area in each case is between 1300 and 2000 cycles, and that definite, rather sharp-cut harmonic bands are shown in all cases except one (the Tamaulipas Crow). In the Sinaloa and Common crows the spectrograms demonstrate a quite curved form to the harmonic bands, but it is not the case with those of the Fish Crow and the Tamaulipas Crow. The coarseness and generally blurred appearence of the picture in the Tamaulipas Crow was shown to be due to the very low frequency of the fundamental and the multiplicity of quite narrow resonance bars crowding together in the area of general resonance (dark region; see Fig. 33).

TABLE 2

SUMMARY OF AUDIO-SPECTROGRAPHIC ANALYSES OF SOME NORTH AMERICAN CROWS

Species	Fundamental frequency, (cycles/second)	Pitch (cycles/second)	Dominant harmonic
Sinaloa Crow	394 (male)	1575	4th
	496 (female)	1884	4th
Common Crow	638 (male)	1276	2nd
	752 (female)	1504	2nd
Fish Crow	281	1390	5th
Tamaulipas Crow	82.5 (male)	1255	15th
	90 (female)	1350	15th
American Raven	56.2	975	17th

Data developed from the analyses of typical calls are shown in Table 2 (information on the American Raven is included for comparative purposes).

SUMMARY

Audio-spectrographic analyses of typical calls of various species of North American crows were made and the results presented. It was found in the cases studied that the Sinaloa Crow had the highest pitched voice of all the species, whereas the Tamaulipas Crow had the lowest. The similarity of the form of the voice of the Tamaulipas Crow to that of the American Raven was pointed out. The Sinaloa Crow was proposed as a new species, *Corvus sinaloae*, from Escunapa, Sinaloa, Mexico.

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THE NESTING OF THE CANADA GOOSE AT DOG LAKE, MANITOBA

BY ROBERT B. KLOPMAN

THE purpose of this paper is to describe the nesting chronology, nest-site characteristics, density relationships and productivity of an isolated population of Canada Geese (*Branta canadensis interior*) in central Manitoba. Several studies of wild Canada Geese have dealt with the nesting period and have evaluated breeding success in the United States (Dow, 1943; Craighead and Craighead, 1949; Miller and Collins, 1953; Naylor, 1953; Naylor and Hunt, 1954; Geis, 1956; Steel *et al.*, 1957; and others); but, up to the present time, the nesting ecology of the Canada Goose has not been studied intensively in Canada.

ACKNOWLEDGMENTS

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AREA AND METHODS

The Study Area.—During 1954 and 1955, I examined the ecological requirements and general behavior of this species at Dog Lake, Manitoba, from spring arrival to the completion of the nesting season. This lake, located in the west-central section of Manitoba's Interlake District, lies within the forest ecotone known as aspen parkland (Bird, 1930). It is over 125 square miles in area and is surrounded by gently rolling country which, prior to 1900, was almost entirely covered by either brûlée or dense aspen growth. Considerable portions of forest have now been leveled to provide farm land and pasture.

The shape of Dog Lake is roughly circular, but two prominent bays project, one to the north and another to the southeast. Maximum depth varied from seven to 10¾ feet during the study years, and was estimated to have been approximately five feet during the dry summer of 1953. Shoreline slope was very gentle both on the mainland and on the islands. In 1954, nine distinct islands were present; and, although rising water the following year covered the smallest island, at the same time a new one was created by the cutting off

of a peninsula from the mainland. Indeed, water level changes have had a striking effect upon the animal life of these islands. In the early part of this century when water extended to what has been termed the "surveyed" lake bank (1900 shoreline delineation, Survey Branch map, Manitoba Dept. of Mines and Natural Resources, 1948), only two large wooded islands and a rock outcropping on another island protruded on this lake. According to the Otto family (pers. comm.), residents in the region since 1910, a ditch constructed in 1914 drained a great quantity of water from Dog Lake to nearby Lake Manitoba. Although Survey Branch records do not confirm this history, the lake level dropped to such an extent at that time that new, small islands became visible. It was apparently during the summer of the following year that Canada Geese were first heard calling in this region. The emergence of these flat islands and of vast reaches of former lake bed thus appears to have coincided with the start of breeding by Canada Geese at Dog Lake. Today this sort of island appears to be the preferred nesting area, whereas the former lake bed surrounding the lake was judged essential during the brooding period.

Methods.—I carried out my field work from March 22 to August 30, 1954, and from March 25 to September 20, 1955. About 10 days after the birds arrived in spring, a crew of three men assisted me in searching likely nesting areas which surround the lake. Nests were usually located by first finding the waiting gander. The team then narrowed its scope of searching in order to find the female and her nest. Undoubtedly some shoreline nests were overlooked because the pairs "sneaked" away from the site. Some pairs showed a proclivity for such behavior, but this mattered little on the islands where all ground could be covered thoroughly. As soon as the ice left the lake, this nest searching was extended to the islands. Trips to the nests were sometimes made as often as every other day. Such frequency seemed necessary in order to determine accurately the dates for the beginning of each nest and its hatching time.

Nesting Chronology

The Start of Nesting.—Geese arrived at Dog Lake on April 8 in 1954 and were estimated to have begun nesting about April 26. In the following year, they arrived on April 1 and evidently started nesting as early as April 9.

The start of the nesting season was arbitrarily designated as that estimated time at which the first egg was laid. I assumed that the date of laying of the first egg could be estimated if clutch size, the rate of laying, incubation period, and the hatching date were known. If the clutch was incomplete, the first-egg date was computed by dating back from the day the final egg was laid, allowing 1.5 days for the laying of each egg (Kossack, 1950). If

TABLE 1
ESTIMATED DATES FOR THE START OF NESTING

Location	Date	Year	Total Nests	Reference
California	February 24	1951	360	Naylor, 1953
California	March 15	1952	201	Miller and Collins, 1953
Manitoba	April 9	1955	44	This study
Manitoba	April 26	1954	60	This study

the clutch was complete, first-egg dates were reckoned by dating back from the hatching day (hatching dates were accurate to within one day). The estimated laying period plus an assumed average incubation period of 26 days (Kossack, 1950) was then set as the interim between the first egg and hatching.

The average date for first eggs in this two-year Manitoba study was 43 days later than the mean for the two studies in northeastern California (Table 1). According to Hopkins' "bioclimatic law" (Chapman, 1931:223), a difference of four days should result for every degree difference in latitude, and the expected difference in this case would be 40 days. However, in view of the small samples available for comparison, the degree of conformity to this rule should be regarded as merely indicative.

Length of Season.—In comparing length of nesting season as determined in various Canada Goose studies, I found two with a significant deviation from the mean of 64 days for all studies. The shortest period reported was 53 days in this study, and the longest, 83 days in California (Table 2).

The direct factors which serve importantly to lengthen the season are the destruction of early nests and late renesting. At Dog Lake, early nests are

TABLE 2
LENGTH OF THE NESTING SEASON

Location	Number of days	Total Nests	Year	References
Manitoba	53	44	1954	This study
California	60[1]	360	1951	Naylor, 1953
Manitoba	61	60	1955	This study
Illinois	61	24	1945	Kossack, 1950
Utah	61	84	1937	Williams and Marshall, 1937
California	65	249	1940	Dow, 1943
Illinois	69	28	1946	Kossack, 1950
California	83	201	1952	Miller and Collins, 1953

[1] Excluding two presumed renesting attempts, one of which involved infertile eggs and embryos dead in an early stage of development.

particularly vulnerable to predation by foxes (*Vulpes fulva*) and coyotes (*Canis latrans*) because at this time the ice still permits ready access from the mainland. Therefore, in theory, the sooner the ice breakup occurs after the start of nesting, the less probability that this sort of nest destruction will result. Also, as mentioned later, some early nests are destroyed by flows of ice moving overland. In both instances the pairs concerned were thought to have renested, for new nests were found very close to the old. Peter Ward (pers. comm.) finds that full-winged, color-banded geese on the Delta marshes, Manitoba, renest after the initial nest has been ruined.

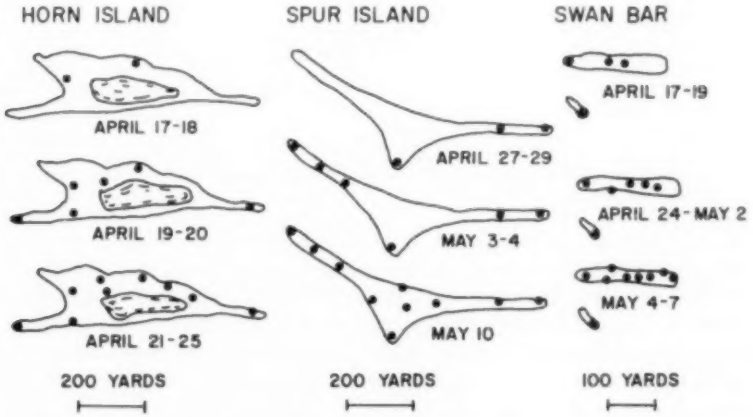

FIG. 1. The number and location of Canada Goose nests on certain islands of Dog Lake at various time intervals (Spur Island, 1954; Horn Island, 1955, and Swan Bar, 1955).

What mainly accounted for the shorter nesting season at Dog Lake in 1954 was the absence of late renesting. In other words, the peak hatch came around June 13 and the last nest hatched five days later (Figure 2). In California, however, Naylor (1953) found a new nest nine weeks after nesting had begun. Figure 2 suggests, nonetheless, that late renesting may occur rarely at 51° north latitude when first nesting begins relatively late.

In addition, my observations in this region suggest that a goose, already incubating for 10 days or more, may no longer be capable of renesting. Certainly this aspect of reproductive potential in geese deserves further study.

CHARACTERISTICS OF THE NESTING SITE

Nest Sites.—Except for a few nests, nesting at Dog Lake was restricted to the islands. In 1955 there was a marked shrinkage in island size because of rising water levels, and with it an increase in the number of nesting pairs.

TABLE 3
NUMBER OF NESTS PER ACRE ON ISLANDS

	Acreage 0.25–1		1–1.5		Above 10	
	1954	1955	1954	1955	1954	1955
With forest						
Sugarbush Id.					0	0
Little Sugarbush Id.					2(0)[1]	4(1)
Gull Rock Id.					3(0)	4(0)
Without forest						
Long Bar	4(4)	3(0)				
Swan Bar		15(4)	5(5)			
Horn Id.			4(2)	11(8)		
Pelican Id.			7(5)	12(0)		
Rocky Bar	5(1)[2]					
Spur Id.			12(8)	5(2)		

[1] The number of nests successfully hatched is given in parentheses.
[2] Covered with water in 1955.

In spite of this, the number of nests on the mainland remained constant. When islands are present, a definite preference for them has been found (Geis, 1956; Naylor, 1953), provided they embody the essentials of a good breeding ground as outlined by Williams and Sooter (1940). Wild geese at Dog Lake showed a preference within island types: they preferred islands which supported no mass of tall tree growth. The three largest islands had dense stands of box elder (*Acer negundo*), elm (*Ulmus americana*) and aspen (*Populus tremuloides*), particularly at the edge of the old lake bank. These large islands were rimmed, in addition, by an extensive border of exposed former lake bed, from 50 to approximately 200 yards in width, an area which appeared to offer a suitable nesting situation for geese. Nevertheless, nests per unit area on forested islands were far fewer than on the treeless ones (Table 3). It is also possible that when geese are given a choice, small islands are preferred (Geis, 1956).

Visibility at the nest site has been stressed by many investigators (Williams and Marshall, 1937; Williams and Sooter, 1940; Dow, 1943; Kossack, 1950; Miller and Collins, 1953; Naylor, 1953; and Steel *et al.*, 1957). At Dog Lake, because of the uniformly flat terrain, this site character was difficult to evaluate. It can be stated, however, that no nests were built there in dense stands of vegetation and that none was found within 100 yards of forest cover.

In some regions, islands are utilized to a great degree even though visibility on them is limited. At Holkam Hall, Norfolk, England, Canada Geese (*B. c. canadensis*) nest in high concentration on islands covered with heavy

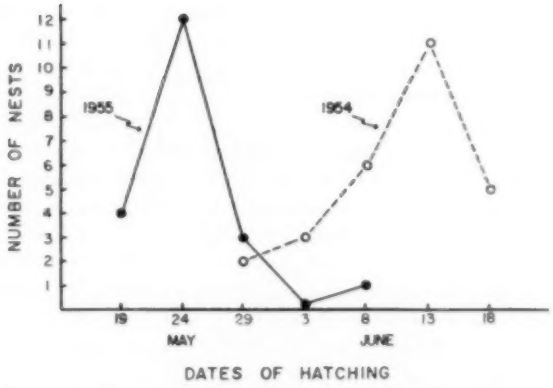

FIG. 2. The distribution and pattern of establishment of successful nests, Dog Lake. Data for 1954 and 1955 are combined. Sample size: 27 nests in 1954; 20 nests in 1955.

shrub and tree growth (Klopman, in prep.). On Flathead Lake, Montana, 25 per cent of all island nests were located in woods or under thick shrub cover (Geis, 1956). Possibly a hierarchy of preferences operates so that, in a given area, islands *per se* provide a stronger stimulus to nest than do other localities regardless of the visibility characteristics. Once the pair begins nest-site searching on an island, other stimuli, such as optimum visibility, nearness of other nesting pairs, etc., then function to determine the exact location of the nest. In marsh habitats a different arrangement undoubtedly exists, for in many instances marsh islands do not provide dry and substantial ground nor are they at times surrounded by enough water to prevent intrusion by predatory mammals.

Time of nest construction in relation to the available sites may prove important in determining the location of a particular nest. At Holkam Hall, England, for instance, only nests begun relatively late were found in the interior of islands where, in my judgment, visibility was poor.

At Dog Lake, 12 of 104 nests were located more than 40 yards from water. The farthest nest, in fact, was 300 yards from water. On the tree-covered islands, all 13 nests were found within 20 yards of open water. Birds on the smaller islands were prevented from nesting, in most cases, on the gravel midrib because of an absence there of nesting material. Sites to one side of the rib were naturally closer to water. In 1955, when island size was reduced, nests were of necessity nearer the water. In short, whereas nests on the large, forested islands demonstrated a "selection" for sites near the water, those on the smaller islands provided inconclusive evidence in this regard

because all available nesting terrain was situated so near the water. Other workers, however, (Williams and Marshall, 1937; Williams and Sooter, 1940; and Miller and Collins, 1953) have shown more clearly a relationship between site location and proximity of water.

In most instances, nest sites near water offer better visibility for gander and incubating goose than do sites situated elsewhere. They also provide the young, particularly, with quick escape from mammalian predators, and afford immediate access to a food source (in some areas) and to bathing.

On six occasions, I moved nests of wild geese at Dog Lake from three to 12 feet from their original site and reconstructed them. In all but one case, the new nest site was accepted. In this single instance, the initial site was nearly surrounded by water. I shifted the nest and rebuilt it 12 feet away. Upon my return the following day, I found that all four eggs and nest material had been reassembled in the original scrape.

At Dog Lake no nest sites were re-used the second year. This may be explained in part by the annual alteration in island size and shape, and to some degree by the gross uniformity of the terrain utilized for nesting. Geis (1956) found many nest sites re-used in successive years.

Nesting Materials.—Goose nests are built with the material found no farther than a few feet from the scrape. As is the case with many early-nesting species, the goose's breeding habitat provides only last season's dead growth for nest material. The types of plant matter available were quite limited at this time on Dog Lake. Prairie grasses were most abundant, and *Phragmites* was second in availability. Nonetheless, only 15 per cent of the nests that I studied were constructed completely of grasses, whereas 55 per cent of them were made of dead *Phragmites* (Table 4). This decided preference may indicate that harder, more woody vegetation provided a stronger stimulus to the nesting goose than did the less ligneous grasses. At the same time, preference may be based on relative diameter rather than on structural quality. Nest material ranged in diameter from that of grass to that of dead poplar branches (2 to 7 mm.). Most of the substances utilized were approximately 5 mm. in diameter. Some nests were composed of two different materials and, if they were both about the same thickness, they were found mixed. If there was a considerable difference in diameter, the thinner plant growth, for example a grass, was normally used to line the cup.

Density Relationships

Nesting Density.—Breeding-pair density at Dog Lake was much higher than is usually reported for wild populations of the subspecies *B. c. interior* or *B. c. canadensis*. For instance, in 1955, Swan Bar (approximately one-sixth of an acre) was settled by at least 10 different pairs and was the site

for 15 nests. Two nests on this island, estimated to have been started the same day, were but nine yards apart.

Although they do not give comparative figures, Hanson and Smith (1950) state repeatedly that within production centers around Hudson and James bays breeding pairs of these subspecies were scattered with seldom more than one pair to a particular lake. J. J. Tuck (pers. comm.) observed an average of only one pair to the square mile of muskeg in Newfoundland. On the basis of 10 years' experience in Michigan, Johnson (1947) recommended "no more than one nesting pair to each half acre or acre" in a management program.

TABLE 4

NESTING MATERIAL UTILIZED BY CANADA GEESE

Plant Species	No. Nests	Per cent
Reed (*Phragmites communis*)	47	55
Pigweed (*Chenopodium*)	13	15
Grasses (Gramineae)	12	14
Goldenrod (*Solidago* spp.)	5	6
Rush (*Juncus* spp.)	3	4
Wild rose (*Rosa* sp.)	2	2
Sweet clover (*Melilotus alba*)	1	1
Wild aster (*Chryopsis* sp.)	1	1
Cocklebur (*Xanthium canadense*)	1	1
Poplar seedling (*Populus tremuloides*)	1	1
Total		100

More nearly comparable to density conditions at Dog Lake are those cited for certain breeding concentrations of *B. c. moffitti* in western United States. For instance, Jensen and Nelson (1948) reported an island-nesting unit in southeastern Idaho with a density equivalent to 54 to 66 nests per acre. Naylor (1953) mentioned an island at Honey Lake, California, which supported 31 nests on one-half an acre. In the Blitzen Valley, Oregon, C. S. Williams (pers. comm.) found 11 nests on a single haystack.

In other breeding concentrations of this western subspecies, however, Jensen and Nelson (*op. cit.*) noted only one pair per acre, and 74 per cent of all nests located by Geis (1956) involved densities between 2.7 and 0.5 per acre. Breeding densities in certain parts of Oregon ranged from 9.7 to 6.0 pairs per square mile (Morse, 1952).

Williams (pers. comm.) and Hochbaum (pers. comm.) suggest that each breeding unit may evolve a pair distance that is specific to the colony. This view, however, precludes any year-to-year density variation within a colony. Such changes are known to have occurred at Dog Lake. It seems more reason-

TABLE 5
COMPARATIVE MEAN NEAREST-NEIGHBOR DISTANCES
TAKEN FROM MAPS AND EXPRESSED IN MAP-MILLIMETERS

Islands	1954	No. Nests	1955	No. Nests
Spur Island	7.9	10	7.0	5
Swan Bar	9.0	5	3.1	15
Horn Island	11.5	4	6.1	9
Pelican Island	8.7	7	8.0	12
Long Bar	14.0	4	11.6	3
Mean of all bars and islands	9.4		6.4	

able to assume that these differences, barring differences in breeding-population size, may be a function of habitat. That is, each habitat offers a different number and distribution of nesting niches.

The insular and annual density changes that occurred at Dog Lake were expressed at nearest-neighbor distances (Clark and Evans, 1954). These measurements, taken from nest locations plotted on maps, showed that the distance between nests on five selected islands was about 32 per cent less in 1955 than in 1954 (Table 5). Reasons for the increased density in 1955 were (1) the persistence of island-nesting, (2) the rising water levels that reduced the size of islands, and (3) an increase in the number of breeding pairs.

The Chronology of Nest Establishment and its Significance.—The time of building and the location of successive nests on an island are, in my opinion, important to a better understanding of how nest densities develop.

In the examples selected for study below are those islands that afforded the largest numbers of nests with complete nest histories. Some nests on the islands cited could not be included because of insufficient information concerning their start. The time of nest establishment was computed by a method mentioned earlier.

One difficulty with this method of analysis is that on a given island one cannot be sure of the length of time that nest sites were defended prior to building the nest. To assume that this was nearly constant from pair to pair or that it is of short duration (less than one week) may be presumptuous. If, for instance, all pairs that eventually nested on a given island are present and defending areas from the onset of nesting, then Figure 2 may only represent differences in timing of the nest-building urge.

However, from observations of these areas in early spring I found that, while some of the pairs that finally nest are present from the beginning of nesting, there is a definite succession in the formation of defended areas. This may, to some extent, be reflected in the differences in nest-building dates. Those birds that have not begun site-searching usually rest on the water and

ice adjacent to the island and often continue feeding flights to the mainland. A week after their arrival, it is common to find many pairs collected around an island, and later to locate only a few nests there.

Figure 1 represents the number and location of nests on certain islands at various arbitrarily selected time intervals.

The time between the establishment of the first and last nests on an island varied from eight to 20 days. In the latter case, renesting was thought to have accounted for the three latest nests. Within a given year and with one exception, first nests were begun on each island on about the same date. In 1954 and 1955 nesting began six to seven days later on Pelican Island than on other islands. This island was the only regular nesting site in this region for large colonies of Ring-billed Gulls (*Larus delawarensis*) and White Pelicans (*Pelecanus erythrorhynchos*).

One might have assumed that the initial pairs to settle an island represent the older birds and thus the ones most apt to be the least tolerant of their neighbors. However, some of the earliest nesters had the lowest average nearest-neighbor distance.

Unlike colonial nesting in many other birds, the pattern of nesting among these geese does not expand outward from an initial focal point, i.e., in the geese the nearest-neighbor distance decreases as the number of nests increases. One might think that, if this were a process of constantly filling the spaces between, the first two or three nests established on an island would be the maximum possible distance apart. This was not the case. In the absence of any apparent site tradition (Hochbaum, 1956), these nest sites may be, for some reason, "better" than other sites available at the time.

In general, the nearest-neighbor distances on a given island were fairly constant and indicated an even spacing of nests over the available nesting ground. With a density arrangement and development of this kind, it is apparent that nests already present on an island greatly influence the location of those that follow. Thus site "selection" in this instance may be largely determined by social interactions among pairs.

Productivity

Nesting Success

Those nests located in which eggs hatched are termed the successful nests in this paper. Nest success was 61 per cent in 1954 and 35 per cent in 1955 (Table 6). Many factors operate to reduce the number of successful Canada Goose nests. At Dog Lake the most important of these were flooding, predation and desertion.

Flooding.—In 1954 eight nests were lost to flooding, and in 1955, 16 nests. In general, above-average precipitation was recorded at the nearest weather

TABLE 6

CAUSES OF NEST FAILURE IN PER CENT FOR SEVERAL GOOSE NESTING STUDIES

Location of area	Total nests	Per cent success	Predation	Flooding	Desertion	All others	Reference
Manitoba	44	61	21	18	0	0	This study, 1954
Manitoba	60	35	8	27	18	12	This study, 1955
Two years combined	104	46	13	23	11	7	
California	169	53	27	1	7	12	Dow, 1943
California	249	15	15	14	7	4	Dow, 1943
California	360	68	4	2	24	2	Naylor, 1953
California	115	72	17	0	11	0	Naylor and Hunt, 1954
California	201	79	3	5	11	2	Miller and Collins, 1953

station during the spring in both years studied (Table 7). Having no outlet today, Dog Lake accumulates considerable agricultural-drainage water in the spring and summer of wet years. Drainage runs from east to west, and three main ditches bring water from approximately 15 miles east of the lake. Farm land is drained either into the ditches or directly into the lake. In wet years Lake Manitoba may also overflow into Dog Lake. The gross accumulation of water from May, 1954, to May, 1955, amounted to approximately three and three-quarters feet.

Due to the increase in lake water after ice breakup, almost half of all nests both years were begun during periods of rising water. Exposed lake-bed perimeters of all islands were so remarkably flat that minute rises in water levels would inundate wide stretches of shore. After the ice breakup in 1955, islands were found drastically reduced in size as compared to the previous year. Some had shrunk to one-twentieth of their former area. One island was completely covered by water, and a mainland peninsula used by nesting geese had vanished. Another point of land was cut off at its base, and was

TABLE 7

PRECIPITATION (IN INCHES) IN THE SPRING OF 1954 AND 1955 AS COMPARED TO NORMAL PRECIPITATION

Manitoba Station	April	May	June
Gimli			
1954	1.67	1.94	5.08
1955	1.00	2.88	2.79
10-year mean	0.87	1.80	3.55
Dauphin			
1954	1.70	1.65	5.51
1955	2.22	1.99	4.63
30-year mean	0.73	1.70	2.70

hence termed an "island" in 1955. Cattle fences needed in the dry year of 1953 were found up to 500 yards out into the lake; and many of these were later covered from sight.

In 1954 only those nests within about 15 feet of water were vulnerable to flooding. In the following year, islands were generally so small that few sites were high and dry. Goose nests on the flat bars or islands at Dog Lake were spaced, not clumped in distribution, so that in 1955 most nests were dangerously close to the water.

TABLE 8

CAUSES OF NEST FAILURE, DOG LAKE, 1954–1955

Causes of Failure	Number of Nests 1954	1955	Total
Flooding	8	16	24
Desertion	0	11	11
Due to pelican nesting	0	6	
Due to gull nesting	0	1	
Unknown causes	0	4	
Observer disturbance	0	5[1]	5
Human exploitation	6	0	6
Fox predation	3	3	6
Herring Gull predation	0	2	2
Ice movements	0	2	2
Total	17	39	56

[1] Due to the use of blinds.

Storm winds provide the driving power to carry water to the nest. In 1954, four nests were lost on June 8, a day marked by rain and southwest winds of 35 miles per hour. Again on May 23, when three nests were destroyed by water, winds swept northeast at 30 miles per hour. The only remaining nest flooded that year was built one foot from water. Of the 16 nests inundated in 1955, six were torn apart as a result of a storm on May 5.

Predation.—Nest failures due to predation totaled 21 per cent of all nests in 1954 and eight per cent in 1955 (Table 8). The principal predators were foxes, gulls and man.

In both years, foxes became stranded on one of the forested islands after the ice melted. Once on an island, they seemed to have no difficulty in dstroying goose nests, as evidenced by the destruction of all but one nest in both years on Gull Rock Island. Except that broken egg shells were never found near the nests, the destroyed nests resembled those which Dow (1943) and Sooter (1946) described as destroyed by coyotes. The nest down always smelled strongly of fox urine, and usually a scat could be found near the nest.

Conclusive evidence showed that foxes at Dog Lake will swim from one

wooded island to another. However, no fox sign was found after ice breakup on the treeless islands, so that these animals are possibly attracted only to islands with dense tree and shrub cover. If this is so, they would normally miss the bulk of the breeding geese.

In 1954 one nest, built before the lake ice broke, was disrupted by a fox.

Predation attributable to Herring Gulls (*Larus argentatus*) accounted for two of 104 nests and occurred only in 1955.

A quarter of a mile of water separates Horn Island from the Dog Creek Indian Reservation. While on a routine inspection trip in mid-May, 1954, I noticed that two seemingly undisturbed nests on this island contained no eggs. Another nest like this was discovered a few minutes later on nearby Little Sugarbush Island. After close scrutiny on the latter island, I located two campfires surrounded by the remains of many boiled duck eggs. Hand-made oars had been used as kindling. The goose eggs had apparently been taken elsewhere for eating or incubation under hens. A week later all eggs from three goose nests on Spur Island were missing. Both cases seem to have been the result of human predation.

Prior to the 1955 nesting season, both the Bureau of Indian Affairs, Winnipeg, and the local authorities were informed of these activities. That year no such disturbance was detected. It is quite possible, however, that egging has been and will continue to be a tradition for some people at Dog Lake.

It is quite significant that two well-known predators of waterfowl nests, the skunk (*Mephitis mephitis*) and the Common Crow (*Corvus brachyrhynchos*), occurred in considerable numbers in this region but did no damage during the study years. In fact in 1954, after the ice had left the lake, a skunk was stranded on one of the smaller islands. Judging from the scats at its bed, it had probably been there four days or more before I found it. Three goose nests were nearby and intact. Crows, although numerous on the mainland, were rarely seen on the islands during spring and summer.

Desertion.—This cause of nest failure was strangely absent in 1954, but rose to 18 per cent in 1955 (Table 8). It is significant that with a sharp increase in density during the second year, no desertion could be directly attributed to the crowding of nesting pairs of Canada Geese. Six goose nests were abandoned when White Pelicans colonized around them. Another incubating goose deserted apparently because a Herring Gull nested a few feet away. The cause of desertion of four nests was unknown.

Other causes of nest failure.—In 1955, when I attempted observation of nests from blinds, five nests were abandoned as a result. Two of these nests were in the first week of incubation, the others in the second week.

As the ice is breaking up, wave action sometimes pushes large sections of ice overland. In this manner, two nests were destroyed in 1955.

Nest Failure as Compared to Other Goose Studies

It can be seen from the two-year aggregate of the Dog Lake data (Table 6) that flooding accounted for more than one-half of all nest destruction. Roughly two-fifths of the total failure can be assigned to predation and desertion. Only 48, or 46 per cent of the 104 nests, were successful. This figure is much lower than the nesting success of four out of five of the other studies available for comparison.

In northeastern California, desertion and predation were the primary forces that lowered nesting success (Table 6). There most desertion was caused by intraspecific conflict in contrast to the interspecific strife which accounted for nearly all desertion at Dog Lake. Predation varied from over 50 per cent of the total nest failure in one study to but 15 per cent in another. No particular form of predation was common to all studies of this species. Flooding, a factor which proved so important at Dog Lake, contributed little to nest failure in most of the California studies. Very possibly, as Naylor (1953) found, nesting there begins after the maximum run-off period.

Hatching.—The hatching period extended from May 28 to June 17 in 1954, and from May 15 to June 8 in 1955. The actual difference in the length of the hatching period was only four days between years. However, the last four nests hatched over a 16-day period in 1955, whereas the final four nests hatched in three days the previous year. The distribution of successful (hatched) nests for the two years, when grouped in five-day intervals, appears somewhat similar (Figure 2). One might suspect, however, that the spacing of the final four nests in 1955 indicates that these may have been renests. But how can we be certain that some early renesting did not occur in 1954? From the distribution of hatched nests alone it is difficult, if not impossible, to differentiate between the span of valid first nestings and dispersed increment of renests.

Production.—Young per successful nest averaged 4.8 in 1954 and 5.5 in 1955. The total number of young believed to have left the nest was 129 in the first year and 115 in the second. Because of the vastness of the region and the shyness of the birds, only a few broods could be seen on a given day, so that no estimate of gosling mortality can be offered in the present paper. Mixing of broods was not apparent, although family groups did flock during the molt.

Mean clutch size for 40 nests in 1954 was 5.0 ± 2.5 eggs and in 1955 it was 5.2 ± 2.5 eggs for 53 nests. One nest of 11 eggs was excluded from the 1955 data because some of the eggs were found outside the nest, and it seemed doubtful that all eggs were the product of one nesting.

Hatchability of Canada Goose eggs in the wild usually approaches 90 per cent. At Dog Lake in 1954, 95 per cent of the eggs in successful nests hatched;

in 1955, 97 per cent hatched. Infertile eggs amounted to five, or four per cent, in 1954, and one, or one per cent, in 1955. Only one instance (one per cent) of embryonic mortality was identified both years. In each year one chick (one per cent each year) was found dead soon after hatching.

Summary

In 1954 and 1955, Canada Geese at Dog Lake, Manitoba, began nesting with all lake water frozen. Compared to two published studies for northeastern California, the start of nesting was about 43 days later, and the season normally shorter in this study. Of the 104 nests, 94 per cent were found on islands, most of which were small and without forest cover.

Breeding densities at Dog Lake exceeded those reported for wild populations of the subspecies, *Branta canadensis interior*. Maximum density was expressed as 10 different pairs or 15 nests on one-sixth of an acre. The minimum distance between active nests was nine yards. Area differences in density were thought to be the result of habitat peculiarities. Annual insular densities at Dog Lake showed a 32 per cent increase from 1954 to 1955. Earliest nests on islands were not the maximum possible distance apart, and nearest-neighbor distance decreased as the number of nests increased. Site "selection" appeared to be influenced by social interactions between pairs.

Nest success was 61 per cent in 1954 and 35 per cent in 1955. For the two-year aggregate, flooding accounted for more than 50 per cent of total nest failure, and predation and desertion together, about 40 per cent. The principal predators were foxes, gulls and man. Desertion was caused mainly by interspecific friction.

The hatching period extended from May 28 to June 17 in 1954, and from May 15 to June 8 in 1955. Mean clutch size was 5.0 ± 2.5 eggs in 1954, and 5.2 ± 2.5 eggs in 1955. Despite the increase in young per successful nest from 4.8 to 5.5, the number of young believed to have left the nest was 129 the first year and 115 the second.

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LOCOMOTION OF WOOD DUCKS

BY PAUL A. STEWART

A STUDY of several aspects of the life history of the Wood Duck (*Aix sponsa*) was recently conducted in central Ohio. Survival was of primary concern, and some attention was given to the means utilized by this species for escape from capture. Although speed alone seldom assures escape from pursuing predators, it is a pertinent factor in maximum escape efficiency. The readiness with which Wood Ducks move into different environments may be a more important life-saver than speed itself, but versatility is sometimes more meaningful to the extent that it is supplemented with quick changes. How quickly can a pursued Wood Duck move from land to water or from water to land?

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SWIMMING SPEED

It is difficult to obtain data on maximum swimming speeds of Wood Ducks because, when pressed, the flightless young either dive beneath or skitter over the surface of the water, and the fully feathered ducks take flight. As would be expected from its slowness, swimming alone is used for only leisurely escapes.

Three measurements of swimming speeds were obtained for day-old ducklings. For these measurements a lane was constructed of two pieces of chicken wire placed parallel in a vertical position about 6 inches apart and extending from the shore toward the center of a pond. This lane was 20 feet long and the wire extended 4 inches above the surface of the water. The ducklings were released near the shore into the lane, and the time they spent in swimming at an approximately uniform speed was measured with a stop watch. When the birds ceased swimming and dived or skittered over the water, the watch was stopped and the swimming distance was measured. As the measurements were taken immediately before the ducklings resorted to a more speedy method of escape, it is believed that approximately maximum swimming speeds were recorded. The speeds of 3 ducklings ranged from 0.8 to 1.2 feet per second with an average of 0.9 foot per second or 0.6 of a mile per hour. Hochbaum (1944:120) reported that flightless adult Canvasbacks (*Aythya valisineria*) swim at a rate of 2 to 3 miles per hour.

Diving

When pressed immediately on leaving the nest, the ducklings dived and swam under water for short distances. The length of time four ducklings just out of the nest remained under water was measured with a stop watch; the periods of submergence varied from 7 to 13 seconds. One day-old duckling came to the surface 7.5 seconds after diving 16 feet from the spot where it had submerged. When under water, this bird swam an average of more than 2 feet per second.

By the time the ducklings were 3 to 4 weeks of age, they swam submerged through much greater distances. Unsuccessful attempts were made to determine the time spent and the distance moved under water by ducklings at more advanced ages. Ducklings more than 2 to 3 weeks of age seldom reappeared on the surface of the water before reaching protective plant cover. Sites 75 feet from the nearest shore were chosen for the release of several ducklings 3 to 4 weeks of age in an effort to measure their time and distance under water, but in each case the ducklings were not seen again. When ducklings were released near the shore, they commonly dived, swam a short distance, came out on the shore, and ran into plant cover. Presumably these birds which were not seen after being released 75 feet from shore swam all of the distance to plant cover before they emerged from the water.

Skittering Speed

Skittering is accomplished by the duck's elevating the anterior part of its body higher than in swimming and by running, with much splashing, over the surface of the water. One measurement of the skittering speed of a day-old duckling was made in a similar method to those of the swimming speeds. This duckling skittered at the rate of 8.5 feet per second or 5.8 miles per hour for a distance of 17 feet. The skittering speed of an adult male in the flightless stage of the postnuptial molt was 75 feet in 5.4 seconds, a rate of 14.0 feet per second or 9.5 miles per hour. This is faster than the maximum terrestrial speed of 13.3 feet per second or 9.1 miles per hour for the Red Squirrel (*Tamiasciurus hudsonicus*) reported by Layne and Benton (1954: 103). Hochbaum (1944:120) reported a skittering speed for flightless male Canvasbacks of 8 to 10 miles per hour.

Running Speed

Tests of running speed were made on a plot of almost-level, closely-grazed pasture. A liberal application of paint was smeared on the bottoms of the ducklings' feet before release. Measurements of strides included the distance from the anterior end of one track to the anterior end of the next track. The time travelled in an approximately straight line was measured with a stop watch. In spite of the fact that ducks in general do not appear well adapted

for running, young Wood Ducks can run rather rapidly, and one bird 3 to 4 weeks of age ran 10.4 feet per second for 24 feet. During the first several yards, which are not included in this calculation, its strides were only about 5 inches long, but after running several yards its strides lengthened to 8 inches. Each of three other ducklings 3 to 4 weeks of age ran 8 to 9 feet per second. The strides of two of these ducklings were 7 to 8 inches long, but one duckling made strides 12.5 inches long. This duckling did not move correspondingly faster and covered only 8 feet per second. These ducklings made 7.7 to 15.4 strides per second, or each stride required one-eighth to one-fifteenth second of time. They ran at the rate of 5.5 to 7.1 miles per hour. The maximum observed terrestrial speed of a Wood Duck was 12 feet per second or 8.2 miles per hour. This was the performance of a bird 6 to 7 weeks of age.

The maximum running speed of 8.2 miles per hour is not markedly lower than running speeds recorded for some terrestrial species of birds. Cottam, Williams, and Sooter (1942:131) recorded maximum running speeds of 10 miles per hour for three Ring-necked Pheasants (*Phasianus colchicus*), and 12 and 15 miles per hour for two Road-runners (*Geococcyx californianus*). Even among mammals maximum running speeds of only 10.6 miles per hour for the Chipmunk (*Tamias striatus*), 9.1 for the Red Squirrel, and 17.0 miles per hour for the Gray Squirrel (*Sciurus carolinensis*) have been reported by Layne and Benton (1954:103).

Flight

The flight speeds of eight Wood Ducks over a distance of 204 feet were measured through the use of a stop watch. The watch was started when the birds had flown approximately five feet after being released. There was little or no wind when the measurements were made, and the birds flew almost horizontally. The flight speed of these eight birds averaged 45.8 feet per second or 31.2 miles per hour with a range of 27.8 to 34.8 miles per hour.

Because of variations under which the birds were flying, as well as variations in making measurements, it is difficult to find published data on flight speeds for comparison. Speeds from 26 to 72 miles per hour have been recorded (Cooke, 1937) for various species of ducks. McLean (1930:1–2) noted that the speed of a Cinnamon Teal (*Anas cyanoptera*) increased from 32 to 59 miles per hour when the bird was chased. Doubtless a higher speed could be attained after flight had been in progress for a longer period of time than was the case in this experiment with Wood Ducks.

Motion pictures were taken of four Wood Ducks when flying in order to determine the number of wing beats per unit of time. These birds were followed with the camera for several hundred feet after they were released. The

pictures were projected at a slower speed and the wing beats of the birds on the screen were counted. These four birds made 7 to 7.5 wing beats per second. Aymar (1935:144) reported that the Goldeneye (*Bucephala clangula americana*) makes 9 wing beats per second. At 31.2 miles per hour, the Wood Duck moves approximately 6.5 feet at each wing beat.

Summary

1. Day-old ducklings when pressed swam an average of 0.9 foot per second or 0.6 of a mile per hour.

2. Day-old ducklings remained submerged a maximum of 13 seconds. One swam 16 feet under water.

3. One day-old duckling skittered over the water at the rate of 8.5 feet per second or 5.8 miles per hour. An adult male in the flightless stage of the postnuptial molt skittered at the rate of 14.0 feet per second or 9.5 miles per hour.

4. Three Wood Ducks at 3–4 weeks of age ran a maximum of 10.4 feet per second. The longest strides were 12.5 inches. The maximum running speed was 12 feet per second or 8.2 miles per hour by a bird 6–7 weeks of age.

5. The average flight speed of eight Wood Ducks soon after being released was 31.2 miles per hour.

6. Four Wood Ducks in flight made 7 to 7.5 wing beats per second, moving forward approximately 6.5 feet with each wing beat.

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Indiana Department of Conservation, 311 West Washington Street, Indianapolis, Indiana, August 15, 1957

GENERAL NOTES

Notes on movements, territory, and habitat of wintering Saw-whet Owls.—The Saw-whet Owl (*Aegolius acadicus*) occurs locally in relatively large numbers within its winter range. Nevertheless there are few published data concerning the movements, habitat requirements, and territorial behavior of these wintering birds. The discovery of small groups of Saw-whet Owls on the Edwin S. George Reserve, Livingston County, Michigan, enabled us to obtain information on these topics during the winters of 1955–56 and 1956–57. We should like to acknowledge the assistance of the following persons who helped us search for owls on several occasions: Laurence C. Binford, Gerald L. Brody, Evan B. Hazard, Robert L. Kirby, Paul Slud, and Dale A. Zimmerman.

The owls were found in a small, open planting of 36 young red pines (*Pinus resinosa*) in an upland field, and in an 82-acre tamarack (*Larix laricina*) bog, which was broken at intervals by ponds and elevated "islands" of oak-hickory woods (Fig. 1).

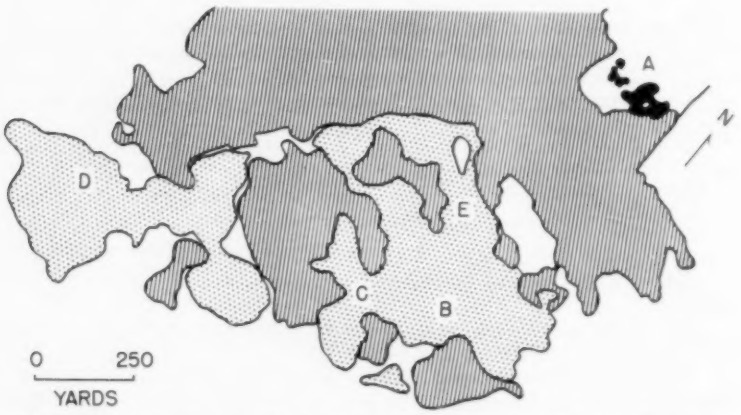

FIG. 1. Map showing areas (A, B, C, D and E) where Saw-whet Owls were found. Stipple represents tamarack bog; crosshatching indicates hardwoods; black represents a red pine planting; white areas represent upland or wet field.

We located owls by walking systematically through the bog, each person 30 to 40 feet from the next. The owls usually perched within a foot of the trunk on a horizontal branch of a bare tamarack. We undoubtedly overlooked owls on a few occasions, but the apparent absence of an owl was probably real in most cases. In the pine planting we carefully searched each tree, and were quite certain of an owl's absence when no bird was found. The fact that an owl had been in a particular tree was often revealed by pellets, excreta, or feathers on the branches. We marked some of the roost trees with strips of cloth for later identification.

The owls were caught by hand, flushed into a Japanese mist net, or flushed into a long-handled net. Each bird captured was banded with a U.S. Fish and Wildlife Service band, and the tips of the tail feathers were painted with red, blue, or white airplane dope. Several of the birds were too wary to permit capture.

Since owls were found in only a few circumscribed areas within the tamarack bog and surrounding upland, these areas will be designated by letters as follows: A represents the red pine planting; B, C, D, and E represent areas within the tamarack bog. The dates and locations of all birds are given in Figs. 2 and 3. Each small circle indicates an unsuccessful attempt to find birds in a particular area, whereas the presence of a bird is indicated by a number. Numbers 1 through 16 refer to individuals found on different days, or in different areas on the same day. Birds are numbered consecutively as found. An underlined numeral represents a bird which was caught, banded, and painted; the same underlined number always represents the same individual. Numbers not underlined represent birds which were not caught, and therefore could not be re-identified. (It should be noted that two different numbers, if not underlined, may or may not represent the same individual, and that the same uncertainty exists where a number not underlined precedes an underlined one.)

Winter of 1955-56 (Fig. 2).—During this winter we banded six birds. Numerals 1, 4 and perhaps 2 may represent a single owl since owl 1 (January 7) was perched in the same tree as owl 4 (January 22). Owls 3, 8, and 10 were banded but were not observed a second time. At least four owls occupied the tamarack bog and pine planting in January. Of these, owls 4 and 5 were found in three of the five areas between January 18 and February 12, but after that time each was found in only one of the areas. Owl 7 was first captured in area D, and, although it was banded and released near area A, it was subsequently found twice in its original area. During February and March each bird

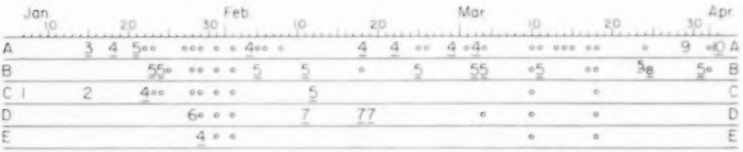

FIG. 2. Dates and locations of Saw-whet Owls, 1955–56.

apparently favored a particular area for roosting (owl 5 even perched on the same branch intermittently for almost a month), but judging from our failure to find owls on certain days, it appears that no bird restricted itself entirely to one area.

Winter of 1956-57 (Fig. 3).—We banded only two owls this winter, failing to catch others on four occasions because of their wariness. One of the latter (owl 12) was found on December 8 in the same tree used by owl 5 the previous winter. Since we found that, even with a bird in the hand, a band could be hidden by the tarsal feathers, we were unable to determine if this was, in fact, owl 5. No banded owl from the previous winter was recaptured. Owl 14 (January 5) was found in the same tree used by owl 15 (January 12), and the two numbers may represent one individual. Owl 15, found in area D, was released after banding in area A, but unlike owl 7 of the winter before, it apparently did not return to area D. Owl 16 was found in area D a month later. Owl 11, observed only three times during a three-month period, appeared each time in a different area. Each of these areas had been used regularly by owls during the previous winter.

Our data on movements of Saw-whet Owls are meager, but they clearly demonstrate that one cannot safely assume that owls found on several occasions in one area represent a single individual. A wintering Saw-whet Owl may roost primarily in a single area for

several months, or it may range over a considerable area (about 100 acres in our study), utilizing a number of roosting sites during a winter. Reimann (1940. *Auk*, 57: 254) states, ". . . it appears that the Saw-whet Owl, on its winter habitat, is constantly wandering from one locality to another." Our data suggest that wintering Saw-whet Owls are somewhat more stable. The three owls (8, 9, and 10) which appeared in areas A and B in late March and early April (1956) may have been migrants, although owl 5 had not yet abandoned its winter roost on March 31.

Owls 15 and 16 were unusually wary. In trying to catch these birds we flushed them many times in succession. Each time a bird was flushed, it flew from 40 to over 100 feet. The direction of flight was not always the same; in general the bird flew progressively farther from its original perch. When owl 15 had reached a point about 230 yards from its initial perch, however, it doubled back, and eventually perched near its original roost tree. Further pursuit caused it to repeat the circuit, during which it sometimes perched in the same trees used the first time, or in trees marked with droppings from previous roosting. Owl 16 behaved in a similar manner, but twice flew circuits which took it about 350 yards from its original roost tree. The bird eventually flew to this tree and retrieved a decapitated mouse which it had left on a branch. It flew to a nearby tree, carrying the mouse in its talons. We flushed it again but did not see it thereafter. These observations suggest that each owl knew intimately a particular part of a larger section of suitable habitat, and utilized several trees within this part for roosting. We do not know whether or not each bird defended its roosting area from other Saw-whet Owls. The fact that we found only one owl per area per day implies that the birds maintained small territories. The only exception occurred in area B on March 24, 1956, when owls 5 and 8 were perched 50 yards apart.

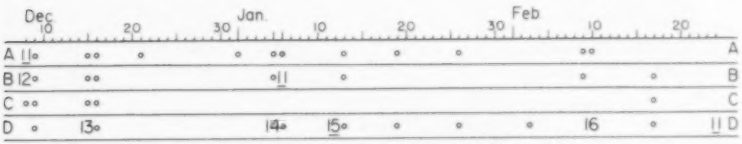

FIG. 3. Dates and locations of Saw-whet Owls, 1956–57.

Several facts indicate that areas A, B, and D constituted especially favorable roosting habitat for Saw-whet Owls. First, one bird utilized all three areas during one winter; second, six different birds used area A, four used B, and four used D during the two winters; third, owls were seldom found away from these areas, although we searched the entire tamarack bog a number of times; and fourth, during the second winter two unbanded owls were caught in these areas, suggesting that different owls chose the same sites independently.

Area D consisted of tamaracks 15 to 25 feet (mostly about 20 feet) in height. The trees were rather uniformly spaced about six feet apart. Their trunks were essentially free of branches from the ground to a height of approximately six feet. The chief associates of the tamaracks in this area were poison sumac (*Rhus vernix*) and bog birch (*Betula pumila*), both of which averaged four feet in height. Hence there was a zone about two feet in depth which was more or less free of branches. When flushed, Saw-whet Owls swooped down from their perches (which averaged seven feet from the ground) and flew through this relatively open space. In area B the tamaracks were taller and the shrub associates sparser than in area D; here the natural pruning of low branches again left an

open zone. Most other parts of the bog contained either very small, widely spaced tamaracks associated with poison sumac, or large trees (30 to 40 feet tall) with an almost impenetrable understory of high-bush blueberry (*Vaccinium corymbosum*) and poison sumac. The red pine planting (area A) differed in structure from areas B and D in its lack of a shrub layer, the presence of foliage, and the presence of dense branches extending down to the ground. The trees, 11 to 24 feet high, occurred in small clumps, separated by areas of grass. An adjacent stand of closely planted, taller red pines was never utilized by Saw-whet Owls to our knowledge.

Of the 82 acres of tamarack bog available, only two small sections (B and D) consistently harbored Saw-whet Owls. These areas were characterized by rather small trees and a relatively open zone allowing easy access or escape by flight below the tops of the trees. An easy approach or escape was also possible in the red pine plantation. The choice of small trees, vines, or bushes for winter roosting has been repeatedly mentioned in the literature. Perhaps selection has favored birds using small roost trees through their consequent isolation from the larger owls and hawks.—Russell E. Mumford and Richard L. Zusi, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan, October 23, 1957.*

Sex ratios of wintering scaups in Long Island Sound.—A study of scaup ducks wintering in the Connecticut waters of Long Island Sound was conducted during the winters of 1952–53 and 1953–54. Whenever possible during the study, sex ratios of observed birds were recorded. Additional scaup sex ratio data were also obtained from hunter bags and trapped birds in Connecticut from 1952 to 1954, and from hunter bags in Rhode Island during the 1954–55 season.

The data were obtained with funds supplied by the Connecticut State Board of Fisheries and Game under Federal Aid to Wildlife Restoration Project W-7-R and The Rhode Island Division of Fish and Game under Federal Aid to Wildlife Restoration Project W-18-R. The sex ratios for the birds taken in Long Island were supplied by Donald Foley of the New York Conservation Department.

Both the Greater Scaup (*Aythya marila*) and the Lesser Scaup (*Aythya affinis*) occur in southern New England, but, since most of the sex ratio data were obtained by field observations which precluded any positive identification of the species, the data cannot be applied to the particular species. However, hunter bag checks indicate that the wintering scaup population in the area concerned consists of 80 to 90 per cent Greater Scaup.

A total of 10,460 birds were sexed by field observation. However, due to the fact that male scaup are often still in immature plumage during the fall, only 9,611 birds observed from January to spring were considered to give a reliable sex ratio. Table 1 summarizes the field observations.

In addition to the field observations, a sample of 113 Greater Scaup collected during the months of October, November, and December in Connecticut had a sex ratio of 109 males to 100 females, and 57 Greater Scaup trapped or collected during January and February in Connecticut showed a ratio of 111 males to 100 females. During the 1954–55 season 62 winter-killed Greater Scaup inspected in Rhode Island indicated a sex ratio of 130 males for every 100 females. Two hundred and eighty-nine Greater Scaup examined on Long Island from 1949 to 1956 showed a ratio of 175 males to 100 females, but 96 Lesser Scaup checked in the same area had a sex ratio of 50 males to 100 females.

Munro (1941. *Canad. Jour. Res.*, Sect. D., 19:113–138) reported that males dominated in wintering flocks of Greater Scaup in British Columbia at ratios of six or seven males to every female. Munro (*op. cit.*) also stated that spring populations of Lesser Scaup

TABLE 1
SEX RATIOS OF SCAUP OBSERVED IN THE FIELD

Month and Year		Number of Birds Sexed	Males : Females		Sex Ratio Male : Female
January	1953	476	355	121	290 : 100
February	1953	2015	1111	904	120 : 100
March	1953	2149	1369	780	180 : 100
April	1953	934	466	468	100 : 100
May	1953	155	97	58	170 : 100
June	1953	4	3	1	300 : 100
July	1953	4	4	0	400 : 0
Total	1953	5737	3405	2332	146 : 100
January	1954	496	319	177	180 : 100
February	1954	2323	1331	992	130 : 100
March	1954	602	363	239	150 : 100
April	1954	453	217	236	92 : 100
Total	1954	3874	2230	1644	136 : 100

in British Columbia had sex ratios of four or five males to every female, and that on the nesting grounds the non-breeding birds, chiefly yearlings, showed an excess of males that was greater than the ratio stated above. Low (1945. *Ecol. Monogr.*, 15:35–69) reported that spring populations of Redheads in Iowa had a sex ratio of 142 males for every 100 females. Sowls (1955. "Prairie Ducks," pp. 162–164), working at the Delta Marsh in Manitoba, recorded spring flights of Lesser Scaup in which the males outnumbered the females 2 to 1, and Furniss (1935. *Wilson Bull.*, 47:277–278) also reported a preponderance of males in spring flights of Lesser Scaup in Saskatchewan, with a ratio of 160 males for every female. However, Sowls (*op. cit.*) did not find this male-dominated ratio in the fall flights of Lesser Scaup. Hochbaum (1944. "The Canvasback on a Prairie Marsh," pp. 149–153) presents an excellent discussion on the possible reasons for the one-sided sex ratios in waterfowl, particularly the diving ducks.—JOHN M. CRONAN, *Rhode Island Division Fish and Game, Providence 3, Rhode Island, November 1, 1957.*

Chimney Swift nesting in an abandoned Pileated Woodpecker hole.—On June 29, 1956, while making a routine investigation of an abandoned nesting hole of a Pileated Woodpecker (*Dryocopus pileatus*), I was startled by the appearance of a Chimney Swift (*Chaetura pelagica*) at its entrance. Subsequent visits throughout the summer indicated that a pair of these birds was using the tree as a nest site. At least one young was successfully fledged in 1956. The nest site was used again in 1957.

The hole was located about 20 feet up in a very old, though still living, yellow birch (*Betula lutea*). There were several holes in the tree, but the one facing out toward the trail was apparently the only one used by the swifts.

It is not a common occurrence to find swift nests in the wild, but it seems even more unusual to find them using a hollow tree where the opening is to the side and not above. —P. B. HOFSLUND, *Biology Department, University of Minnesota, Duluth, Minnesota, November 1, 1957.*

House Wren attempts incubation in two nests simultaneously.—In the course of our studies of the eggs and nesting behavior of birds we come across many anomalous situations. Among the birds most easily studied in our neighborhood is the House Wren (*Troglodytes aedon*), for which in 1957 we had provided some 40 boxes on the Preston Laboratory grounds. These boxes are about six inches square inside. The wren fills the whole base of the box with twigs and generally makes the nest cavity in one of the two rear corners, remote from the entrance hole, which is centrally located in the front. A fair proportion of the birds make the cavity halfway between the two corners, but the most interesting case was a wren that tried to make a nest in both corners and succeeded at the second attempt. This was the wren that occupied our box no. 15.

In late May she scooped out two hollows, but lined only one, and laid her six eggs consecutively from May 24 to May 29, inclusive. These we collected, as we did many others, for studies of shape, pigment, and gloss. We also removed the nesting material in its entirety. The bird was orthodox in proceeding to make a new nest immediately. This time she not only constructed two cavities but proceeded to line them and to lay in them, once more six eggs, one a day from June 17 to June 22, inclusive.

The first egg went into the right pocket, and the second into the left, evening the score. The third went into the left, but the fourth into the right, once more evening the score. The fifth went into the right, and, perhaps to our disappointment, she laid the sixth egg in the right also (see photograph).

Having now distributed her eggs reasonably well between two nests, she proceeded to incubate both. Feeling inquisitive as to how well she could succeed, we left the eggs exactly as she put them. Maybe we should have had still more interesting results if we had placed three eggs in each nest. Although it is practically certain that a "split personality" of this sort is a lethal behavioral mutation, since otherwise species would be known that regularly operate with a plurality of nests, the weather was warm, the box was snug, and we thought she might have a chance. Some days one clutch would be warm, sometimes the other. It seems certain however that the four eggs got more attention than the two.

The first egg hatched on July 4 in the four-egg nest. Two more, in the same nest, hatched on the following day, and the fourth egg hatched on July 6. As soon as one young hatched, the bird ignored the two-egg nest and the eggs were cold. On July 6 we took them out and broke them open. They appeared to have been incubated effectively for two or three days.

It thus appears that a double menage of this type is likely to reduce the output of offspring by one-third or one-half.

When the eggs hatched, the young were necessarily for some days in the nest where the eggs had been, but by July 17 we sometimes found all the young in the other nest, or two in each nest. This continued until July 21 when all four young left the box.

The photograph shows the two nests well lined with feathers. A few hours after the young left not a single feather was left in either nest. We believe they began to disappear before the young left but kept no careful account. What happened to them is not clear. —F. W. Preston, *Preston Laboratories, Inc., Box 149, Butler, Pennsylvania, July 6, 1957.*

Cedar Waxwings and Fox Sparrows feed upon Multiflora Rose.—Multiflora rose (*Rosa multiflora*) is generally considered something of a "starvation food" by some workers who have observed and made use of it in plantings. Johnson (1951. *Jour. Wildl. Mgmt.*, 15(2): 221–222), and Spiegel and Reynolds (1954. *Trans. Nineteenth N. Amer. Wildl. Conf.*: 153–155) demonstrated, however, that the hips are nutritious to pheasants. Rosene (1950. *Jour. Wildl. Mgmt.*, 14(3):315–319) noted that the seeds were carried by water and by birds. At the Patuxent Research Refuge, Prince Georges County, Maryland, casual observations suggest that when there is a crop of hips, Mockingbirds (*Mimus polyglottos*) subsist almost entirely on multiflora rose throughout the winter.

Most of the rose plantings at the Refuge are mature enough to bear a large crop of fruits and there was an abundant supply of these hips during the winter of 1955–56. On February 1, the first flock of Cedar Waxwings (*Bombycilla cedrorum*) for the winter was noted on the Conservation Farm and a perceptible build-up in numbers occurred as the month wore on. On February 23, Leonard Llewellyn made a count of 1,325 birds as they settled on a two-wire power line that extends across the farm. This was a record concentration for the Refuge. Most of the waxwings did not remain after that date, the subsequent counts ranging between approximately 150 and 400, and the last record being about 180 on March 2.

To get an indication of the amount of seed dispersed in places where the birds were frequently seen perching, a piece of burlap sacking, measuring 12¼ square feet was left under a small tree for 6½ hours. At the end of that time there were 16 regurgitations containing 100 seeds or nutlets on the burlap.

A check of tall-fescue sod under 7 large trees which covered 2½ acres as a loose stand and which were used as perches by the birds, showed that large amounts of seed had been deposited, and had worked down into the grass. A randomly selected square-foot of ground close to one of the rose fences was sampled under a large willow oak (*Quercus*

phellos), the crown of which covers about $\frac{1}{50}$ of an acre. Fifty-two nutlets were counted in the square foot.

Fox Sparrows (*Passerella iliaca*) are observed in fair numbers along woodland margins bordering the fields, but on March 17, 1956, there was a noticeable increase of them. Two days later, they were widespread on the farm and particularly noticeable in the rose hedges. From 5 to 10 of these large sparrows fed daily under the above-mentioned willow oak, suggesting they might be taking advantage of the seeds dispersed by the waxwings. Seven Fox Sparrows and one Song Sparrow (*Melospiza melodia*) were collected from this area and their gizzards were examined by A. C. Martin. Six of the Fox Sparrows contained from 60 to 100 per cent multiflora rose seeds and the other about 5 per cent. About 5 per cent of the contents of the Song Sparrow included rose seeds.—FREDERICK C. SCHMID, *U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland, February 15, 1957.*

Nesting of the Black-backed Three-toed Woodpecker in Michigan.—On May 31, 1957, I found a nest of the Black-backed Three-toed Woodpecker (*Picoides arcticus*) in north-central Michigan. During the next few weeks, the nest was visited by a number of people, and I have drawn bits of information from several of them to prepare as complete an account as possible on this little-known species. This was the first nest reported for the Lower Peninsula of Michigan and the third for the state. Two nests were found in the Upper Peninsula in 1941 (Blain, 1941, *Jack-pine Warbler*, 21:72–74) and in 1949 (Bourdo and Hesterburg, *ibid.*, 29:78–81).

The nest was located in Oscoda County less than a mile west of Mack Lake (Sec. 5, T26N, R3E). It was situated in a clearing caused by a fire that had swept through the jack pine (*Pinus banksiana*) forest here on April 2, 1946. This fire had burned about 6000 acres but had left many "islands" of living pines and a few standing dead pines. The ground cover was sparse and the openings were unevenly covered by a new growth of jack pines, the largest of which were a little more than head high. On the same day in 1946, five fires had swept this county, destroying a total of nearly 20,000 acres of forest.

On the day of this discovery, Lawrence H. Walkinshaw and I were in the area looking for Kirtland's Warblers, (*Dendroica kirtlandii*), and it may be more than a coincidence that Norman Wood collected a Black-backed Three-toed Woodpecker in this same region on the trip when he found the first nest of the Kirtland's Warbler in 1903. It may be that the fires which produce Kirtland's Warbler habitat also produce conditions favorable to this woodpecker.

The nest cavity was situated $3\frac{1}{2}$ feet from the ground in a dead jack pine. The tree was $6\frac{1}{2}$ inches in diameter at nest height and was broken off 14 feet above the ground. The entrance was almost circular, $1\frac{3}{4}$ inches in diameter. Walter Nickell probed the cavity with a twig and found it to extend downward 13 inches below the entrance. For at least a quarter of a mile in all directions the trunks of trees were conspicuously marked where slabs of bark had been removed by the feeding activities of this pair. Most of the feeding took place on dead trees, some standing and some lying on the ground.

The woodpeckers were not wary; they approached the nest readily with people standing 10 feet away. The female gave a low-pitched "chuck" occasionally and the male gave calls somewhat like those of the Yellow-shafted Flicker (*Colaptes auratus*). But the birds usually remained at middle or low heights in the forest and were not conspicuous.

At the time the nest was found, and again the following morning, June 1, the female was flushed from the cavity and the male was not seen. We believed the female to be incubating but were unable to see the nest contents with flashlight and mirror. On June 2,

the male was flushed from the cavity; he quickly returned, however, and remained as though incubating. On June 4, Verne Dockham watched the nest from 11:30 a.m. until 4:30 p.m. For the first four hours of this period, only the female entered the cavity, remaining in it for periods of 25, 12, 10, 20, 15, 21, 8, 18, 5, 15, and 4 minutes (average, 14 minutes); and away for periods of 5, 3, 20, 3, 32, 6, 7, 5, 7, 9 minutes (average 9½ minutes). Then the male came to the cavity and remained 50 minutes. The birds were believed to be incubating at this time.

On June 11, Walkinshaw and W. A. Dyer visited the nest and found the adults feeding young whose calls could be heard in the cavity. During a three-hour period on the morning of June 12, the female visited the nest for periods of 22, 1, 2, 38, and 17 minutes; the male visited for periods of 2, 1, 4, 31, and 13 minutes; and the nest was unattended by adults for periods of 14, 7, 20, 7, and 15 minutes.

In a period of three hours and 25 minutes on June 14 and two hours and 10 minutes on June 15, Dr. and Mrs. W. Powell Cottrille noted eight visits by the female on two of which the bird stayed to brood (24 and 19 minutes each); and 11 visits by the male, of which six lasted 6 to 13 minutes and others two minutes or less. The adult male was banded on June 23 by A. J. Berger. There appeared to be two young birds in the nest, one with the yellow head-patch of a male. On June 29 the young birds raised their heads to the entrance, and on June 30 stood in the entrance (one at a time) with heads protruding. Even when hidden in the cavity, the young almost steadily uttered vibrant calls that could be heard more than 100 feet. Verne Dockham found both young birds present on July 2, but only the young male was visible when Walkinshaw and Dyer arrived on July 3. The young bird called incessantly as though very hungry, and the adults did not appear during the half hour the men waited. The next day Dyer spent more than two hours waiting for the adults to appear while the young male called steadily as though in great hunger.

On July 4 at 10:30 a.m., 34 days after the nest was discovered, the young male left the nest, flying 200 feet to a tall dead pine and then on to a grove of living pines, calling steadily. The adults were not seen.—HAROLD MAYFIELD, *River Road RFD, Waterville, Ohio, January 9, 1958.*

American Avocet in Michigan.—On September 22, 1957, Laurence C. Binford, Larry L. Wolf, and I observed an American Avocet (*Recurvirostra americana*) on a pond at the corner of Dunbar Road and U.S. Highway 24 A., Monroe, Monroe County, Michigan. The bird was feeding in water two inches deep about 25 feet from a cat-tail marsh bordering a city dump.

The bird (UMMZ No. 152485) proved to be an immature female; bursa of Fabricius 12 × 10 mm., ovary 12 × 7 mm., weight 338.1 grams, moderately fat.

This appears to be the first specimen for Michigan, although Walter B. Barrows (1912. "Michigan Bird Life," pp. 169–170) reports an unverified specimen taken by W. H. Collins from the St. Clair flats (? Michigan or Ontario) in 1874. Mr. Louis W. Campbell saw an Avocet near the Erie Shooting and Fishing Club Clubhouse, near Erie, Michigan (10 miles south of the collecting site of our specimen) on September 8, 1957. It is likely that the bird seen by Campbell is the one we collected. However, an invasion of the species may be indicated by observations in Ohio. Alta Smith reports having seen an Avocet on September 14, 1957, at Bay Point near Marblehead, Ohio, 45 miles southeast of Monroe, and Jack Confer photographed 12 on the mud flats of the Miami River near Dayton, Ohio, on August 27, 1957.—ROBERT P. KIRBY, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, January 10, 1958.*

Record of the Knot in Texas.—On March 24, 1957, I shot a male and a female Knot (*Calidris canutus*) from a flock of approximately 30 individuals on Mustang Island, four miles southwest of Port Aransas, Nueces County, Texas. The male weighed 114.3 grams and possessed little fat; the female, 126.8 grams, was moderately fat. The birds were changing from winter to summer plumage. Wolfe (1956. "Check-list of the Birds of Texas," p. 29), lists this bird as "probably a rare migrant all along the coast." The fifth edition of the American Ornithologists' Union Check-list states that they are casual winter visitants along the Gulf coast of Texas, migrating in the spring chiefly along the Atlantic coast and through the lower Great Lakes region.

I left the island on March 29, 1957, without seeing the Knot again. The specimens are now in the collection of Southwestern College, Winfield, Kansas (SC201–202).—Max Thompson, *Museum of Natural History, University of Kansas, Lawrence, Kansas, December 6, 1957.*

Bird fossils from the Late Pleistocene of Kansas.—In the summers of 1952, 1955, and 1956, Claude W. Hibbard and his associates collected numerous fossil bird remains in Meade County, Kansas. I am grateful to Dr. Hibbard for the opportunity to study some of this material, and for information about the locality where it was found. Thanks are also due Drs. Harrison B. Tordoff and Robert W. Storer for their advice and assistance in studying the fossils and preparing the manuscript. The specimens are in the collection of the Museum of Paleontology, University of Michigan, Ann Arbor.

All the bones were found in the bank of Shorts Creek, SW ¼ sec. 36, T. 33 S., R. 28 W. The basin or lake deposit is composed of silt, silty clay, and sandy silt. Freshwater snails, a piece of an *Equus* skull, and a muskrat (*Ondatra zibethica*) tooth were associated with the bird remains. On the basis of the stratigraphic position of the deposit and the species of the muskrat, these fossils date from the late Pleistocene and are younger than the Berends fauna (Starrett, 1956. *Jour. Paleo.*, 30:1187–1192).

Pelecanus erythrorhynchos. White Pelican.—A fourth and a sixth cervical vertebra (UMMP no. 30049), both lacking parts of their zygapophyses; brownish white. The fossils are larger than corresponding elements of the Brown Pelican, *P. occidentalis*, and are within the size range of modern White Pelicans. This is interesting in view of the somewhat larger specimen from the late middle Pleistocene of Oklahoma reported by Mengel (1952: *Auk*, 69:81–82).

Chen sp. Goose.—Proximal third of a right carpometacarpus (UMMP no. 34830); the distal end of the basal process and the edges of the carpal trochlea have been worn off; brownish white. *Chen* differs from *Anser albifrons* (White-fronted Goose) in the shape of a transverse ligamental scar at the proximal end of the anconal side of the bone, in the shape of the dorsal margin of the carpal trochlea, and in its deeper anterior carpal fossa. *Branta canadensis* (Canada Goose) resembles *Chen* spp. very closely but examination of the basal process in a series of specimens reveals that it is consistently thicker in *Branta*. The fossil is larger than the comparable element in *C. rossii* (Ross's Goose) but is within the size ranges of *C. hyperborea* (Snow Goose) and *C. caerulescens* (Blue Goose). I am unable to separate the two latter forms by any characters which can be discerned in the fossil. This is the first fossil record of this genus from the High Plains.

Anas sp. Duck.—Proximal third of a left ulna (UMMP no. 34833), slightly abraded; brownish white. The fragment resembles the ulna of *Anas* and differs from those of *Spatula* and *Aythya* in its blunter olecranon, fainter scar for M. brachialis, and larger external cotyla. It closely resembles that of *Mareca* but has a relatively broader shaft

immediately distal to the external cotyla. On the basis of size the fossil may represent *Anas acuta* (Pintail), *A. rubripes* (Black Duck), *A. strepera* (Gadwall), or *A. platyrhynchos* (Mallard).

Anas sp. Duck.—Piece of the right half of a furcula (UMMP no. 34834), slightly abraded; brownish white. The robustness and curvature of this fragment suffice to identify it as either *A. rubripes* or *A. platyrhynchos*.

Aix sponsa. Wood Duck.—Right carpometacarpus (UMMP no. 30053), lacking metacarpal III and lightly abraded on all protuberances; whitish. The fossil closely resembles the comparable element in *Aix* and in *Aythya marila* (Greater Scaup). Careful examination of a series of specimens from both species reveals the following differences and permits identification of the fossil: the anterior carpal fossa is clearly defined in *Aythya* but only suggested in *Aix*; in end view the dorsal condyle of the carpal trochlea is dihedral in *Aythya* and slightly curved in *Aix*; the sides of the external ligamental attachment converge sharply at a point or along a line, forming a pit in *Aythya* whereas they form a rounded depression in *Aix*. This is the first fossil record of the Wood Duck.

Aythya affinis. Lesser Scaup.—Fragment of the distal end of a right humerus (UMMP no. 30050), abraded on the entepicondyle and on the proximal end of the external condyle; brownish white. In size and general shape the fossil most resembles the corresponding element in the following species: *Aythya collaris* (Ring-necked Duck), *Aythya affinis*, *Clangula hyemalis* (Oldsquaw), *Spatula clypeata* (Shoveler), and *Lophodytes cucullatus* (Hooded Merganser). The fossil agrees with *Aythya* spp. and differs from the other species listed in its well-marked scar for M. brachialis. It further agrees with *Aythya* and differs from *Clangula* and *Spatula* in the shape of the olecranal fossa and in its fairly straight, flattened shaft. The most reliable difference between *Aythya affinis* and *A. collaris* which I can find in this bone is the shape of the brachial scar. The apex of the scar is elliptical in *A. affinis* and pointed in *collaris*; its ventral margin is less oblique to the long axis of the shaft in *affinis* than in *collaris*. Using these criteria the fossil can be assigned to the former species. Fossil coracoids and humeri which possibly represented the Lesser Scaup were reported by Downs (1954, *Condor*, 56:211) as part of the Jones fauna, late Pleistocene, Wisconsin age, of Kansas. The present specimen is older than those and constitutes a definite record of the species from the High Plains.

Owing to the similarity of these bones among genera, individual variation within species, and the fragmentary or worn condition of the fossils, the following specimens could only be identified as duck remains: cervical vertebra (UMMP no. 34832), ventral half of left coracoid (UMMP no. 34831), proximal third of right scapula (UMMP no. 30054), left carpometacarpus (UMMP no. 30052), proximal third of right carpometacarpus (UMMP no. 34836), and proximal third of left tibiotarsus (UMMP no. 34835).

Asio flammeus. Short-eared Owl.—Distal end of left humerus (UMMP no. 30051), with summits of the ectepicondyle and the entepicondyle abraded; whitish. The humerus of *A. flammeus* differs from that of *A. otus* (Long-eared Owl) in its wider distal end, greater distance from ectepicondyle to ectepicondylar prominence, and in having a well-defined pit on the entepicondyle. The fossil agrees with *A. flammeus* in all these characters. This is the first fossil record of this species from the High Plains.

According to Tordoff (1956, *Univ. Kans. Publ., Mus. Nat. Hist.*, 8:307–359) all the above-named species are common in at least some parts of Kansas at certain times of the year. Most of the waterfowl now occur only as transients and there is no indication that they did or did not nest in the region during the late Pleistocene. Since the ecologic requirements and tolerances of birds may not be the same when migrating as when

nesting, the fossil evidence of these species tells little about contemporary conditions. There is nothing in this avifauna to contradict the nature of the landscape, vegetation, and climate as postulated by Hibbard (1955, *Univ. Mich., Contrib. Mus. Paleo.*, 12: 203–204). The abundance of duck remains is further indication of marshes and marsh-edged streams and pools. Even as a migrant the presence of a Wood Duck suggests that there were probably at least patches of woods along the lowland streams. The records of pelican and goose point to the existence of fairly large, shallow lakes. Hibbard's suggestion of mixed grasses on some valley walls and on some uplands is supported by the owl remains.—PETER STETTENHEIM, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan, December 3, 1957.*

New records of the Nashville Warbler in Colorado.—The Nashville Warbler (*Vermivora ruficapilla*) is comparatively rare in Colorado. According to Dr. Alfred M. Bailey (pers. comm., November 7, 1957), "There are three specimens taken in the state, including one from Mesa Verde, and several sight records, the most recent being from Colorado Springs, May 19, this year."

To these records we wish to add the following: In August, 1954 (exact date not available), a single bird was observed by a biology class under the direction of Daniel, in a shrubby area near the mouth of the Conejos River Canyon, Conejos County, about 20 miles north of the New Mexico border. On November 1, 1957, an individual flew into the window at the home of Mr. and Mrs. Robert Armagast of Alamosa, Alamosa County, Colorado. It was released on November 2, apparently unharmed.

Both of these locations are in the San Luis Valley which is a high (7500 feet), large, flat, intermontane basin on the eastern slope of the Rocky Mountains.—JOSEPH C. DANIEL, JR., ROBERT M. ARMAGAST, AND JULIA W. ARMAGAST, *Adams State College, Alamosa, Colorado, January 21, 1958.*

Notes on pre-copulatory display in the Starling.—In a recent paper on the breeding biology of the Starling (*Sturnus vulgaris*), Kessel (1957, *Amer. Midl. Nat.*, 58:257–331) brings together some of the European literature on the sexual displays concerned with pair formation and copulation. The following two observations from the field, however, are presented to point out elements of pre-copulatory display which are not included in Kessel's paper. The first observation was made on April 22, 1956, on the grounds of Harvard University, Cambridge, Massachusetts. A Starling, hereafter called "A," was perched in a tree when first seen, but immediately flew down to Starling "B," perched on a lower limb in the same tree. Bird A alighted on the right side of B, and mutual bill rubbing took place. Both birds assumed a sitting position with the axes of their bodies at about a 45° angle with the limb, and rubbed their bills together in a motion resembling bill wiping on a limb, with the exception that it was slightly slower. Then A mounted B for a brief interval, flying up to a higher limb immediately afterwards. Shortly after, B flew to a limb about six feet lower, and both birds began to preen vigorously. Bill wiping against the limb was prominent in the comfort movements. Then A flew down to the side of B again, and mutual billing took place. A mounted B in the same manner as before, after which both birds sat quietly side by side. The entire sequence lasted about two minutes, and was performed in complete silence, as far as I was able to detect.

This observation points to two exceptions and an addition to Kessel's descriptions. She notes that the female "always" pecks the male in the neck just prior to his mounting, and that a second mating never follows the original one (although she acknowledges that it may happen rarely). Moreover, "courtship-billing" as described here is not mentioned

in her paper. In a brief examination of recent literature on the Starling (about two dozen papers in English and German) no reference to this display could be found, although one note (Nethersole-Thompson and Musselwhite, 1940. *Brit. Birds*, 34:44) mentions a somewhat similar movement, which is discussed below.

The origin of behavior patterns of birds is now receiving increased attention (e.g. Daanje, 1950. *Behaviour*, 3:48–98; and Tinbergen, 1952. *Quart. Rev. Biol.*, 27:1–32), and it is thought that most instinctive movements are derived or "ritualized" from more basic patterns, such as locomotion. Moynihan (1955. *Auk*, 72:240–246) has pointed out that many parts of complex displays which were once considered to be of "extraneous" origin, can be shown to be derived from intention movements of more basic actions. Therefore, if courtship-billing is truly "autochthonous" (that is, derived from a motion actually in the context of courtship), it could have one of several sources. Lack (1940. *Auk*, 57: 169–178) gives several examples of mutual billing in bird courtship which are derived from courtship-feeding, although he had no reports of either in the Sturnidae. Recently, however, courtship-feeding has been reported in the Starling as a prelude to coition (Chappell, 1949. *Brit. Birds*, 42:118–119) or coition attempts (Owens, 1949. *Brit. Birds*, 42:181–182), and since billing has now been observed to occur in a similar context, it may be that the latter is derived from an intention movement of the former. Lack also mentions a second origin of courtship-billing in birds which might apply to the Starling. In the courtship, especially of species in whch the nest site is very important in maintaining the pair bond (as it seems to be in the Starling *fide* Kessel, *op. cit.*), often nesting material is passed from one bird to its mate. Marples (1936. *Brit. Birds*, 30:14–20) and Beven (1946. *Brit. Birds*, 39:116) have described behavior similar to this in the Starling, so that billing might have been derived from this source, instead of from courtship-feeding. A third possible authochthonous orgin of courtship-billing is incipient aggression. Courtship in birds often involves an interplay of three tendencies: attack, escape, and sexuality, the components of the first two decreasing, the third increasing as courtship progresses. It is not difficult to visualize the selective advantage of reducing an aggressive peck-thrust to an intention movement resembling billing. However, a fourth, "extraneous" or out-of-context, origin is also possible. It was noted that vigorous comfort movements, especially bill wiping, were characteristic of both birds at the time of courtship. It is conceivable that this comfort motion has been incorporated into the courtship display in a manner similar to the supposed origin of "courtship-preening" in ducks (Moynihan, *op. cit.*). By association with the rest of courtship display, the extraneous movement may acquire by conditioning a "courtship valence" to the female, which can then be acted upon in the males by natural selection. The proposed explanation is well set fourth by Moynihan, and will not be labored here. It is interesting that Nethersole-Thompson and Musselwhite (*op. cit.*) describe a courtship motion similar to ordinary bill wiping by the male Starling, except that the beak does not touch the limb and it is performed conspicuously before the female. They also make note of a "false preening" by the female which functions in the display. The above sources are presented only as suggestions, of course. Before the origin of courtship-billing can be traced, the forms of courtship-feeding, nest material handling, aggression, and comfort movements of bill wiping, as well as the billing itself, must be studied in greater detail.

The second field observation was noted on December 28, 1957, when two Starlings were observed in a small fruit tree near Cabin John, Maryland. Bird "D" mounted "C" very quickly, after which both sat quietly together for a few seconds. Then C mounted D, although no differences could be distinquished in the reverse mounting. Characteristic

wing-fluttering was noted, but no other specific motions were seen in either "mating." Both birds were frightened by approaching people, and took wing during the second mounting. Starling C was unusual in that it was in spring-like plumage, with yellow bill and noticeable spots, although D was in usual winter plumage.

Kessel gives a list of references which record sexual behavior in the Starling throughout the year, and they need not be repeated here. However, the observation raises the problem of winter sexuality in general. Although many of the "ultimate" causes (e.g., increasing day length) affecting sexual behavior have been investigated, published observations on immediate environmental conditions eliciting winter display and copulation seem to be scarce. An investigation of weather maps for the week prior to the second observation here reported showed no unusually warm or changing temperatures. Any conclusive correlation with weather would involve watching marked birds over a considerable period of time.

Kessel does not mention reverse mounting in Starlings, although it has been reported in a brief note by Glick (1954. *Auk*, 71:204). There seems to be no other mention of this in the literature, but it is well known in other species of birds. The second observation also contradicts Kessel's belief that pecking of the female directed at the male's neck or shoulder is a necessary "releaser" for mounting.

In addition to the questions of the origin of courtship-billing and the cause of winter sexuality, it is apparent that there are still many problems concerned with the sexual behavior of the Starling. Although other components of sexual display have been reported (see Kessel's paper with references), we still lack a coherent ethological description of the frequency of display components in the Starling.

Drs. Ernst Mayr and Lawrence Kilham helpfully led me to references and made suggestions about the subject matter, and Andrew Meyerriecks critically read the note and supplied several pertinent references.—JACK P. HAILMAN, *Harvard University, Cambridge, Massachusetts, February 7, 1958.* (Present address: 4401 Gladwyne Drive, Bethesda, Maryland.)

Black-crowned Night Herons using bill motion to lure prey.—The late Witmer Stone, in writing about the Black-crowned Night Herons, *Nycticorax nycticorax* (1937. "Bird Studies at Old Cape May" Vol. 1, p. 148), relates how the birds would stand along the shores of a shallow pond, with the neck deflected and the point of the bill just touching or slightly submerged in the water. On July 14, 1956, while observing a number of those herons feeding along a tidal channel in the Tuckerton Meadows in Ocean County, New Jersey, I had the opportunity to observe three of them at close range and discovered what I believe to be the reason for their odd behavior.

The birds I had under observation were not more than 100 feet from my parked car, from which I watched them through a 20× Balscope held rigid in a window mount. The channel along which they slowly stalked, or stood with bill tip submerged for a few seconds at a time, was partially covered with a green algae that thickened along the shoreline, screening any underwater activity. But the bill tips were not held motionless in that medium. Rather they were opened and closed so rapidly that the motion may best be described as a vibration, the distance between the upper and lower mandibles during the action being very slight but clearly discernible through the glass. This motion would continue for a few seconds; then with a quick thrust of the entire bill into the water, a small fish would be withdrawn and swallowed.

During the hour or more that I kept the birds under observation this maneuver was

repeated time after time. Sometimes the birds would miss a thrust and move forward a few feet and try again. At no time did they move their bills in either a circular or back and forth movement such as they would if they sought to clear the surface in order to see their prey. It is my opinion that in agitating the algae covered surface they were in effect creating a disturbance that would be interpreted by the small fishes as the hapless struggles of their own small prey. It is possible that in their haste to engulf that prey they brush against the herons' bills, thus triggering the quick thrust that results in their own capture.

I have not since had the opportunity to observe herons "fishing" in that fashion nor do I know if they use the same technique when the surface of the water is clear.—HOWARD DRINKWATER, *Old Road, Whitehouse, New Jersey, February 18, 1958.*

NEW LIFE MEMBER

Mrs. J. Murray Speirs (Doris Huestis) received her formal education at Havergal College and the University of Toronto. From an early age she has been intensely interested in animal behavior. The writings of Thoreau inspired her to commence a series of nature journals. Later she began studying the Evening Grosbeak and has travelled to remote places observing the stages of its life history. She is a director of the Federation of Ontario Naturalists, a founder-member of The Margaret Nice Ornithological Club, past-president of the Toronto Junior Field Naturalists' Club and a member of the British Ornithologists' Union.

WILSON ORNITHOLOGICAL SOCIETY NEWS

Josselyn Van Tyne, posthumously, has been named the first Patron of the Wilson Ornithological Society as a result of a gift from an anonymous donor. The donor expressed the wish that this further recognition be given to Dr. Van Tyne in appreciation for his self-sacrificing service to the Wilson Ornithological Society over a long period of years. It would be difficult to enumerate all of Dr. Van Tyne's contributions to the Society, but he will be remembered especially for his distinguished editorship of the *Bulletin*, his leadership as President, and his personal sponsorship of the Wilson Society Library at Ann Arbor, to which his widow, Helen Bates Van Tyne, recently gave his large collection of ornithological works.

At the Thirty-ninth Annual Meeting, held at Wheeling, West Virginia, April 24–27, 1958, the following officers were elected:

President	Lawrence H. Walkinshaw
First Vice-President	Harold F. Mayfield
Second Vice-President	Phillips B. Street
Secretary	Aaron M. Bagg
Treasurer	Ralph M. Edeburn
Editor (beginning 1959)	H. Lewis Batts, Jr.
Elective member of the Executive Council	Ernest P. Edwards

The *Proceedings* of the meeting will appear in the September issue of *The Wilson Bulletin*.

NOTICE

Manuscripts intended for publication as long articles in *The Wilson Bulletin* should be submitted to Dr. H. Lewis Batts, Jr., Kalamazoo College, Kalamazoo, Michigan. Dr. Batts will assume the editorship beginning with Volume 71, 1959. Material for inclusion in "General Notes" should be sent to the present editor.

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been received since January 1, 1957. From:

American Museum of Natural History —43 reprints
G. A. Ammann—1 book
P. H. Baldwin—15 reprints
H. Lewis Batts, Jr.—5 newsletters
Andrew J. Berger—3 reprints
Alexander Bergstrom—9 journals
Herbert Bruns—7 reprints
Donald E. Burton—1 bulletin
George W. Byers—1 reprint
Carnegie Museum—44 reprints
George A. Clark, Jr.—27 reprints, 10 bulletins and journals, 1 book
Ralph W. Dexter—8 reprints
William Dilger—9 reprints
Ralph M. Edeburn—1 reprint, 15 journals
Edward Gray Institute—17 reprints
Frank Egerton III—3 magazines, 1 journal
Fred G. Evenden, Jr.—16 reprints
Finnish Game Foundation—2 reprints
Fish and Wildlife Service—43 publications
Fundacion Creole—1 book
Edith and Henry Halberg—1 reprint
Karl W. Haller—3 reprints, 36 books, 24 pamphlets
R. Hatt—102 bulletins
F. Haverschmidt—5 reprints
Philip Humphrey—1 reprint
Iowa Co-operative Wildlife Research Unit 2 reprints
Jardin Zoologique de Quebec—1 pamphlet
David W. Johnston—3 reprints
Jukka Koskimies—2 reprints
Amelia R. Laskey—1 reprint
T. Lebret—4 reprints
Daniel S. Lehrman—1 reprint
Harvey B. Lovell—1 reprint
William L. McAtee—8 reprints, 1 book
Frank McKinney—2 reprints
Ernst Mayr—1 reprint
Michigan Department of Conservation 1 book
Russell E. Mumford—1 reprint
Museum Zoologicum, Universitatis, Helsinki—2 reprints
Margaret M. Nice—26 reprints, 3 journals
North American Wildlife Foundation —1 reprint
Northeastern Bird-Banding Association —5 journals
Kenneth C. Parkes—7 reprints
O. S. Pettingill, Jr.—1 reprint
Allan R. Phillips—17 reprints
Frank Richardson—1 reprint
Gardner M. Riley—2 reprints
S. Dillon Ripley—3 reprints
Gerald Rogers—144 reprints and pamphlets
Charles G. Sibley—5 reprints
Paul Slud—1 reprint
J. Murray Speirs—1 reprint
Peter Stettenheim—2 translations
Paul A. Stewart—30 bulletins
Robert E. Stewart—2 reprints
Robert W. Storer—100 reprints and journals
Phillips B. Street—1 reprint
Lawrence Summers—1 reprint
Harrison B. Tordoff—15 reprints
Hobart M. Van Deusen—1 reprint
Mrs. Josselyn Van Tyne—3300 reprints
Lars von Haartman—4 reprints
L. H. Walkinshaw—7 reprints
J. Dan Webster—15 reprints
Charles M. Weise—2 reprints
Nixon Wilson—1 reprint
Wisconsin Conservation Department —1 pamphlet
University of Wisconsin—15 reprints
Col. L. R. Wolfe—7 books, 7 journals, 1 reprint
H. E. Wolters—1 reprint
Harriet B. Woolfenden—1 pamphlet
Dale A. Zimmerman—2 reprints
Richard L. Zusi—2 books

ORNITHOLOGICAL LITERATURE

A Population Study of Penguins. By L. E. Richdale. Oxford: Clarendon Press, 1957: 6 × 9¼ in., 195 pp., 2 plates, 8 figs., 87 tables. $6.75.

This highly informative volume is the third among Richdale's major works concerned with penguins. One of these publications covered the first 12 years of research, and another dealt mainly with sexual behavior. The present study, which was written at the Edward Grey Institute of Field Ornithology, Oxford University, is based on a vast amount of data gathered in eighteen seasons (August 1936 to March 1954) of intensive field work on the Otago Peninsula of southern New Zealand. It is concerned principally with a population of Yellow-eyed Penguins (*Megadyptes antipodes*), although there are comparisons with other species of penguins and with certain procellariiform birds. Some 1,318 visits were made in different breeding areas, of which four comprised the "main study area." With ingenuity and perseverance Richdale evolved a satisfactory technique by which individuals were footmarked (with leather-punch perforations in the webs) and banded (with home-made, numbered aluminum bands). An explanation of terms used, as, for instance, "keeping company," "divorce," and "guard stage," is provided in the introductory chapter.

The author outlines the annual cycle of the Yellow-eyed Penguin, thus: (1) the winter period (end of the molting in April until the time when the birds begin spending days ashore in preparation for breeding); (2) the pre-egg stage (ends with the laying of eggs—mid-September to mid-October); (3) the incubation phase (ends in November, in which month nearly all chicks are hatched); (4) the period with young (lasts some 16 weeks, until the end of March, when all chicks have entered the ocean); and (5) the molt period (successful parents molting chiefly in March and later birds in April, but ones without chicks doing so mainly in February). There follow detailed chapters on the following topics: the pair bond, incubation, the chick period, movement, juveniles, influence of age on breeding biology, the penguin community, survival and mortality, and the molting season.

The copious data on population dynamics and associated problems have been manipulated in masterly fashion. The numerous tables are set up clearly and relatively simply, and the text, which is written in lucid and straightforward manner, includes careful and thorough interpretations of tabular matter. One is impressed with the size of most of the samples employed in the analyses. For example, in table 2 is given the annual fate of 737 mated pairs of Yellow-eyed Penguins. "On the average, 60 per cent. of the mated pairs remained intact from year to year, but the annual score varied from 35 to 81 per cent."

Some other gleanings (a tiny sample of what the book contains) might here be offered. The penguins are non-migratory and breed in small colonies. Two eggs are laid; the second appears 3 to 5 days after the first. Both sexes incubate. The incubation period ranges from 40 to 51 days, averaging 43.5 days ($N = 200$, no less). After a discussion of other species of penguins, Richdale concludes that "the incubation period . . . seems to depend somewhat on a generic basis. Certainly it is not on a migratory or geographical basis." There is an excellent descriptive account, based on observations from a blind, of the procedure by which the parents feed the chicks. In the "guard stage," in which one parent is always in attendance, the chicks are normally fed three times every two days. "Once both parents begin to fish simultaneously at the post-guard stage, feeding time procedure changes abruptly." It is easy to see that much painstaking research went into studies of weights of chicks (90–93 grams at hatching, increasing to about 13 pounds at 90 days) and the amount of food they require (one conclusion: "it is . . . understandable why the clutch size could not be greater. I doubt if two parents could successfully rear

three chicks."). There is good evidence that parents normally feed their own chicks but not others; the idea of communal feeding in a "crèche" system is considered to be untenable not only for the Yellow-eyed but also for other kinds of penguins. Of the fledglings that disperse, "some 52 per cent. die in the succeeding months, a few return to the place where they were hatched, and the remainder settle at varying distances." The investigator found "not a single instance of a parent or a grandparent mating with its own progeny," although in dispersal areas some inbreeding takes place among relatives (as brothers and half-brothers with sisters and half-sisters) which have wandered. Most females start breeding in their second or third year, but only about 47 per cent of the males do so (33 per cent more start in their fourth year). It was found that breeding birds comprise about 60 per cent of the total resident population; the rest are non-breeding adults, juveniles, and birds "in transit." The author "never observed a female penguin unmated once it was old enough to produce eggs" (p. 122); yet "males after they have once bred are liable, on the average, to find themselves unmated once in every 7 or 8 years" (p. 135). These observations can be related to the unbalanced sex ratio, which "widens steadily from 100 males to 98 females at the age of 3 years to 100:52 for the oldest group (13 to 17 years)." The greater physiological wear and tear to which females are exposed throughout their lives may be the main factor in their higher mortality rate. Survival-rate values are 88.8 per cent for males, 84.2 per cent for females. As brought out in table 72, "the average expectation of further life for males is 6.8 years and for females 6.0 years." There were records of three birds which lived at least 19 years, and theoretical maximum longevity was estimated to be in excess of 22 years. One interesting conclusion, among others, in the chapter on molting season is that "irrespective of the age of the bird, month of moult, or initial weight, Yellow-eyed Penguins lose on the average about 45 per cent. of their weight from the time when they come ashore to moult until they re-enter the sea after the old feathers have been replaced."

There seem to be few ways indeed in which this book could have been improved. Some readers might wonder whether many of its passages ought to contain more words—including more about the general environment—and fewer quantitative data (percentages, etc.). The reviewer's feeling is that this would not be a valid criticism of a technical study of this sort. Although the study is readable enough, its aim, certainly, is not to "kiss the reader and tuck him in." The statistical analyses and presentations leave little to be desired. The exact way in which certain measurements of chicks (as "bill" and "toe") were taken is not explained, but many other workers, including the reviewer, have also been lax in this respect. There is no indication as to how tests of significance were carried out, or whether P-values as well as t-values (or their equivalent) were employed. The appendix, in which methods of marking penguins are well described, might have been amplified somewhat to include certain other aspects of methodology.

In an age when so many scientific studies are being conducted by teams or super-teams, it is refreshing to find now and again a person who is intimately involved in all phases of his investigations. It looks as if Richdale, despite his gracious acknowledgments of aid from others (including his wife and ornithologists at Oxford), is a notable example of the ornithological individualist who never hesitates to get his hands dirty or his back tired as he assumes, month in and month out, the full work-responsbility for his projects. In this type of researcher and his products there is, in the reviewer's opinion, a certain shade of dignity and integrity which is wanting in the more gregarious workers and their contributions. May the teamless researcher prosper and continue to make himself felt!

"A Population Study of Penguins" is, in brief, a remarkably fine study. By Raymond Paynter it is deemed a classic (1958. Ecology, 39: 176), and the present reviewer would

not disagree. Both the ornithologist, who may be interested chiefly in the ways in which penguins make a living and maintain their kind, and the population ecologist, whose interests may incline toward vital statistics or biodemography, will find in L. E. Richdale's monograph a well-arranged harvest of facts, figures, and ideas about populations and related characteristics of the Yellow-eyed Penguin and kindred species of birds.—ROBERT A. NORRIS.

THE COMPARATIVE BIOLOGY OF THE MEADOWLARKS (STURNELLA) IN WISCONSIN. By Wesley E. Lanyon. Publ. Nuttall Ornithological Club No. 1, 1957: 8½ × 5½ in., 1–67 pp., 31 pl. (Available from Massachusetts Audubon Society, 155 Newbury Street, Boston, Mass., cloth bound, $2.00; paper, $1.50.)

Within the framework of avian systematics today are those knotty problems which deal with geographically sympatric and similar-appearing species. Among these problem species are the Eastern (*Sturnella magna*) and Western (*S. neglecta*) meadowlarks, the controversy over which has ranged since at least the time of Audubon. Various systematists have regarded them as distinct species whereas others have listed them as conspecific, principally on the basis of "hybrids." In an attempt to settle once and for all this issue, Dr. Lanyon has effected a four-year intensive study near Madison, Wisconsin, where the two forms are geographically sympatric but ecologically allopatric.

The present analysis, then, has been a field study wherein the author has compared *magna* and *neglecta* with respect to habitat preferences, adult vocalizations, breeding biology, and the questions of interbreeding. Generally, it was shown that *magna* prefers the moist lowlands whereas *neglecta* shows a preference for the drier uplands. Spectrographic analyses of call notes and primary songs revealed significant differences in frequencies and duration, even though there was considerable variation especially in *magna*. As far as territoriality was concerned, there were rather identical behavior patterns in the two species, and yet there was always complete segregation of territories and interspecific territorialism. Breeding biological data (incubation periods, clutch size, etc.) evinced no significant differences.

Perhaps the most significant part of this report revolves around the question of interbreeding since "hybrids" have been reported in the literature on the basis of vocalizations and/or specimens. Lanyon presents evidence to show that typical *magna* males may, at times, deliver *neglecta*-like songs and vice versa. Furthermore, he reports on a mixed pair in central Illinois. Such a union, however, was apparently unsuccessful, even though an occasional hybrid has been produced in captivity. "Hybrid" and bivalent songs are interpreted by Lanyon as follows—"males of either species are potentially capable of learning and rendering primary song of the other species," (p. 51) so that the bivalent repertory could well be the result of "a more continuous and proximate exposure to singing males of the opposite species." (p. 52). As a conclusion, he states, "The literature contains no clear case of hybridization of Eastern and Western Meadowlarks in the wild and no such evidence was found in this study" (p. 60), but he does concede that hybridization may occasionally occur especially at the periphery of a range.

It would seem that this report has conclusively dispelled conspecificity for these meadowlarks by ecological and song differences which, when coupled with morphological and perhaps ethological data, present effective isolating mechanisms in wild populations. Whereas this is clearly a biological approach, it seems to me that the entire thesis would have been strengthened by at least a cursory treatment of morphological differences.

In so doing, so-called intermediate or hybrid specimens might be more correctly interpreted. —David W. Johnston.

NEW LIFE MEMBER

J. Murray Speirs is a graduate of the University of Toronto. His M.A. thesis deals with fluctuations in the numbers of birds in the Toronto region, and his Ph.D. thesis (University of Illinois) deals with movements of American Robins in the region east of the Rocky Mountains. Both were analyses of field data. He is working on a life history of Lincoln's Sparrow, edits the Bulletin of the Federation of Ontario Naturalists, is a member of the Toronto Ornithological Club and a new life member of the Wilson Ornithological Society.

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